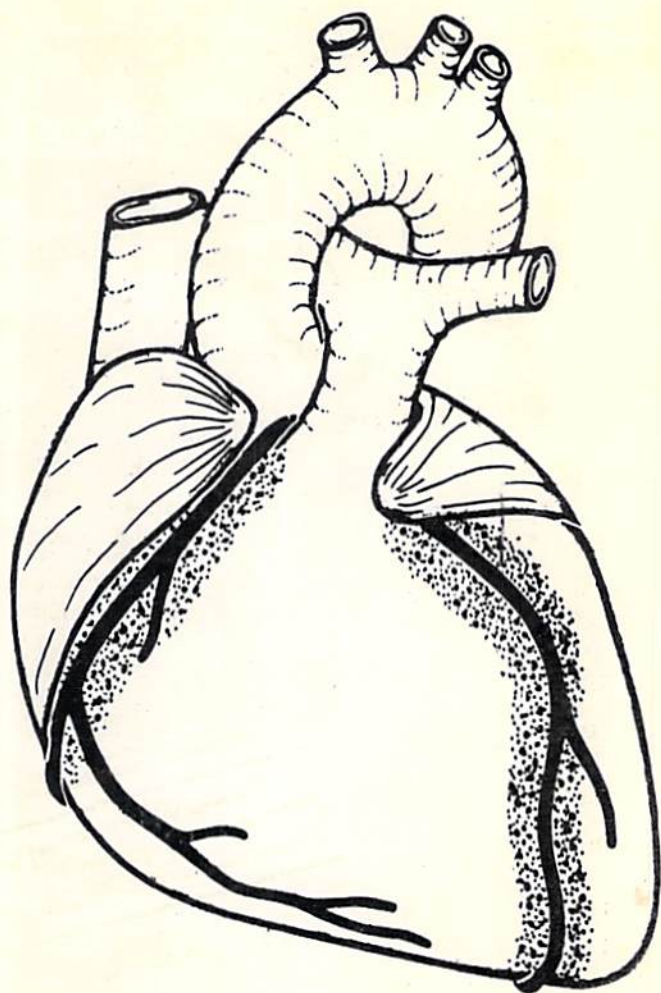
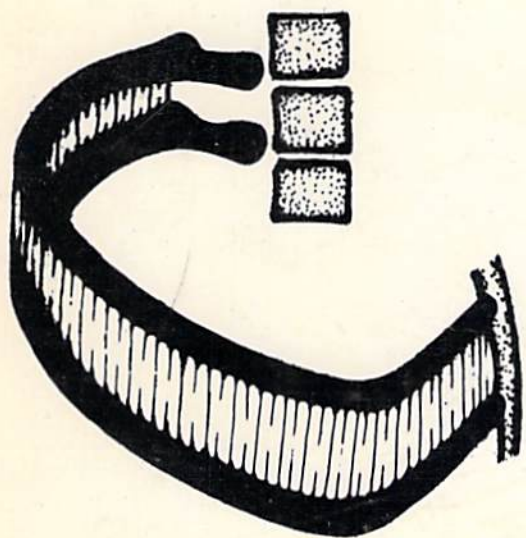


ATLAS OF ANATOMY

THORAX



by
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PREFACE

This " ATLAS OF ANATOMY " contains 443 figures on the anatomy of the thorax including the back. Almost all the anatomical facts are illustrated in a clear way, and the diagrams are provided with concise explanatory notes.

The authors hope that this diagrammatic atlas will be helpful to the medical student as a guide to better understanding of anatomy.

Cairo, 1989

FAWZI GABALLAH

ZAIZAFON BADAWY

PREFACE

OTHER BOOKS BY THE SAME AUTHORS

1. Atlas of Anatomy (other parts).
2. Atlas of Embryology.
3. Basic Human Anatomy.
4. Basic Embryology.
5. Basic Neuroanatomy.
6. A summary of Anatomy.
7. Oral Questions in Anatomy.

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THORACIC CAGE

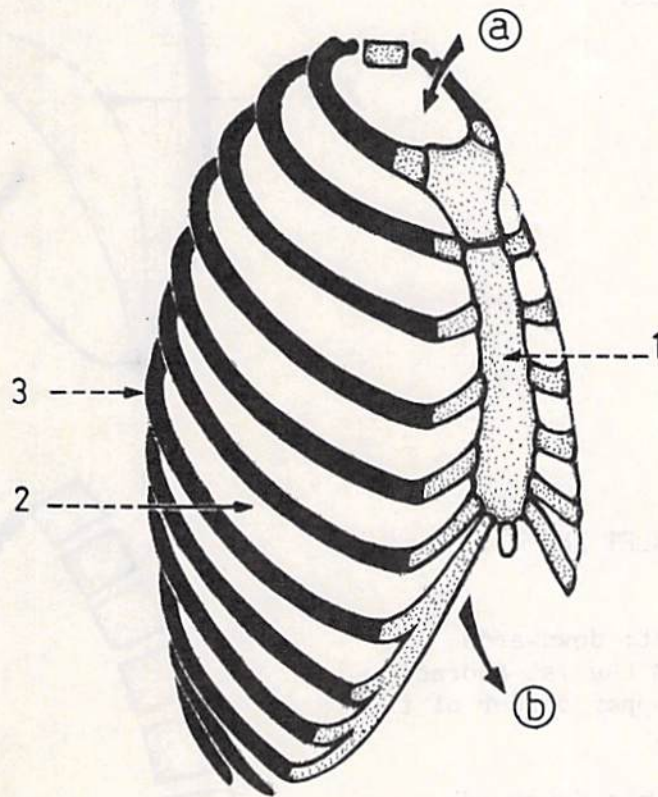


Fig.(1): BOUNDARIES OF THE THORACIC CAGE

The thoracic cage is conical in shape having an inlet, an outlet and 4 walls (anterior, posterior and 2 lateral).

- (a) inlet: is the narrow upper end, and is continuous with the root of the neck.
- (b) outlet: is the broad lower end, and is separated from the abdominal cavity by the diaphragm.
- 1. anterior wall: is formed by the sternum, costal cartilages and anterior parts of the ribs.
- 2. lateral wall: is formed by the ribs.
- 3. posterior wall: is longer than the anterior wall and is formed by all the thoracic vertebrae and the posterior parts of the ribs.

Fig.(2): INLET AND OUTLET OF THE THORACIC CAGE

(a) inlet.

(b) outlet.

1. anterior wall.
2. outline of the diaphragm closing the outlet.
3. posterior wall.

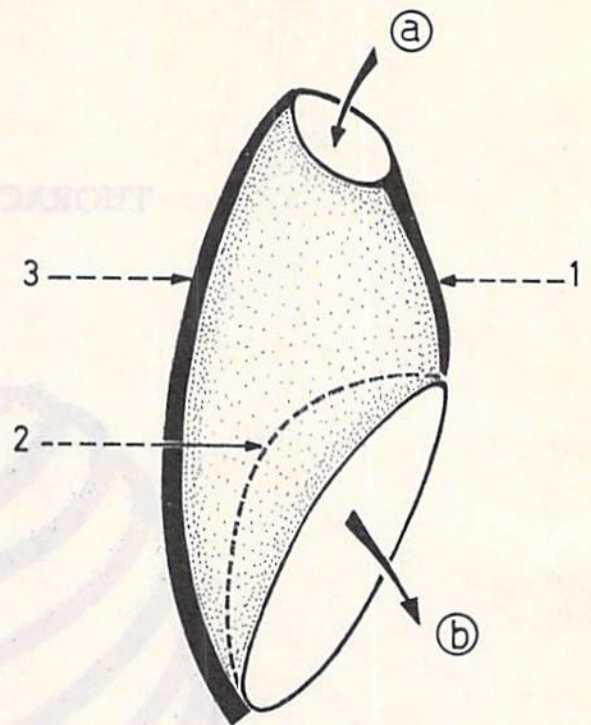


Fig.(3): SLOPE OF THE INLET AND OUTLET

- (a) slope of the inlet: downwards and forwards from the 1st thoracic vertebra to the upper border of the manubrium sterni.
- (b) slope of the outlet: downwards and backwards from the lower end of the body of the sternum to the 12th thoracic vertebra.

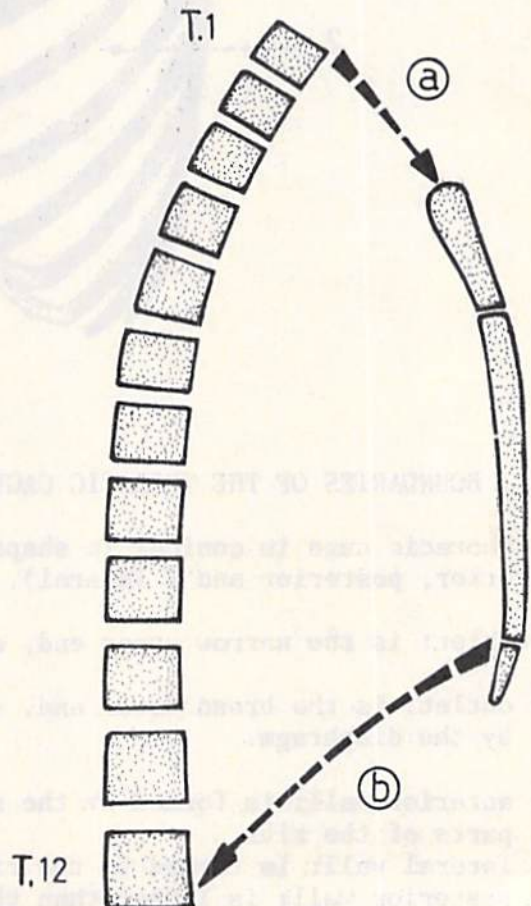


Fig.(4): BOUNDARIES OF THE INLET

The thoracic inlet is bounded by the 1st thoracic vertebra (behind), 1st rib (on each side) and upper border of manubrium sterni (in front).

1. 1st thoracic vertebra.
2. 1st rib.
3. 1st costal cartilage.
4. manubrium sterni.

* Note that the anteroposterior diameter of the inlet is $1/2$ its transverse diameter.

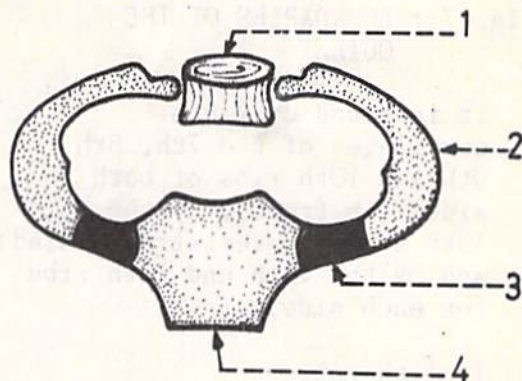


Fig.(5): CERVICAL RIB

It is an abnormal rib which may be found in the root of the neck just above the thoracic inlet. It articulates by its head with the 7th cervical vertebra and if it is long enough its anterior end reaches the 1st rib or the manubrium sterni.

1. 7th cervical vertebra.
2. cervical rib.
3. 1st rib.
4. anterior end of the cervical rib (replaced by a fibrous cord).

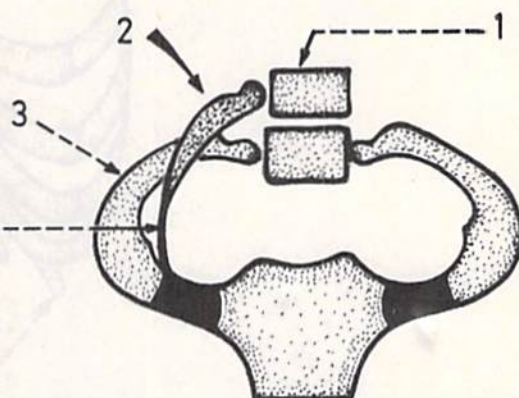


Fig.(6): RELATIONS OF CERVICAL RIB

It may pass below the 3rd part of subclavian artery and lower trunk of the brachial plexus.

1. cervical rib.
2. lower trunk of brachial plexus.
3. 3rd part of subclavian artery.

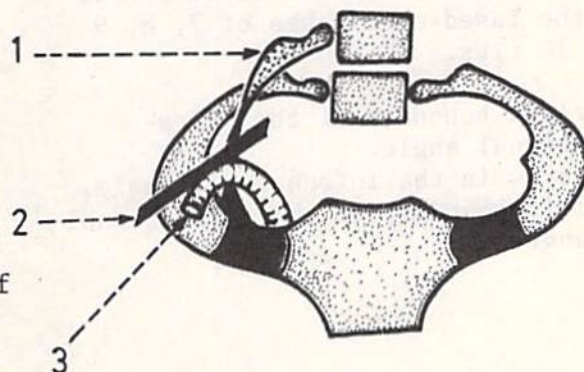


Fig.(7): BOUNDARIES OF THE
OUTLET

It is bounded by the cartilages of the 7th, 8th 9th and 10th ribs of both sides (in front), by the 12th thoracic vertebra (behind) and by the 11th and 12th ribs (on each side).

1. 11th rib.
2. 12th rib.
3. cartilages of 7, 8, 9 and 10 ribs (fused together).
4. 12th thoracic vertebra.

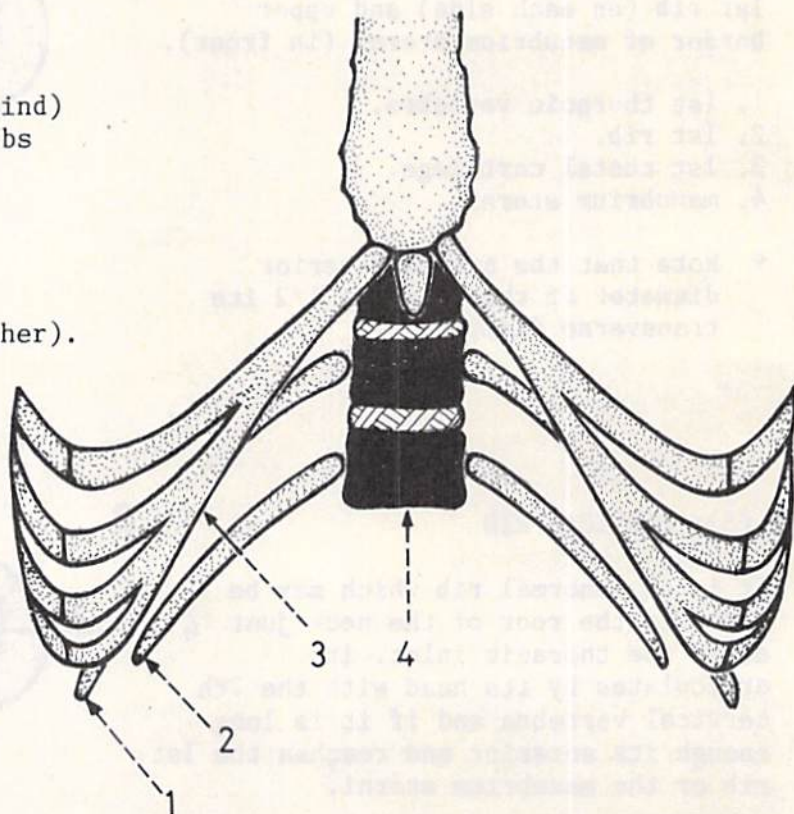
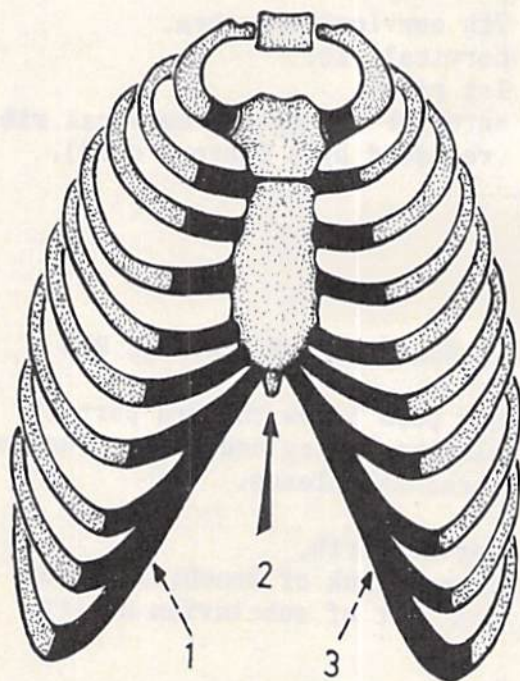


Fig.(8): INFRASTERNAL ANGLE

It is the angle present below the sternum. It is bounded on each side by the fused cartilages of 7, 8, 9 and 10 ribs.

1. right boundary of the infra-sternal angle.
2. arrow in the infrasternal angle.
3. left boundary of the infrasternal angle.



VERTEBRAL COLUMN

Fig.(9): REGIONS AND CURVES OF THE VERTEBRAL COLUMN

The vertebral column is a part of the axial skeleton and consists of 33 vertebrae which are arranged in 5 regions: cervical, thoracic, lumbar, sacral and coccygeal.

- (a) cervical region: consists of 7 vertebrae and is convex forwards.
- (b) thoracic region: consists of 12 vertebrae and is concave forwards.
- (c) lumbar region: consists of 5 vertebrae and is convex forwards.
- (d) sacral and coccygeal regions: consist of the sacrum (5 fused vertebrae) and 4 coccygeal vertebrae. These 2 regions form a curve which is concave forwards (form part of the pelvis).

- 1. 7th cervical vertebra.
- 2. 12th thoracic vertebra.
- 3. 5th lumbar vertebra.
- 4. sacrum.
- 5. coccygeal vertebrae.

* Note that the thoracic and sacral curves which are concave forwards are called primary curves because they are the same as the original concave curve of the column in the foetus, while the cervical and lumbar curves which are convex forwards are called secondary curves because they appear after birth.

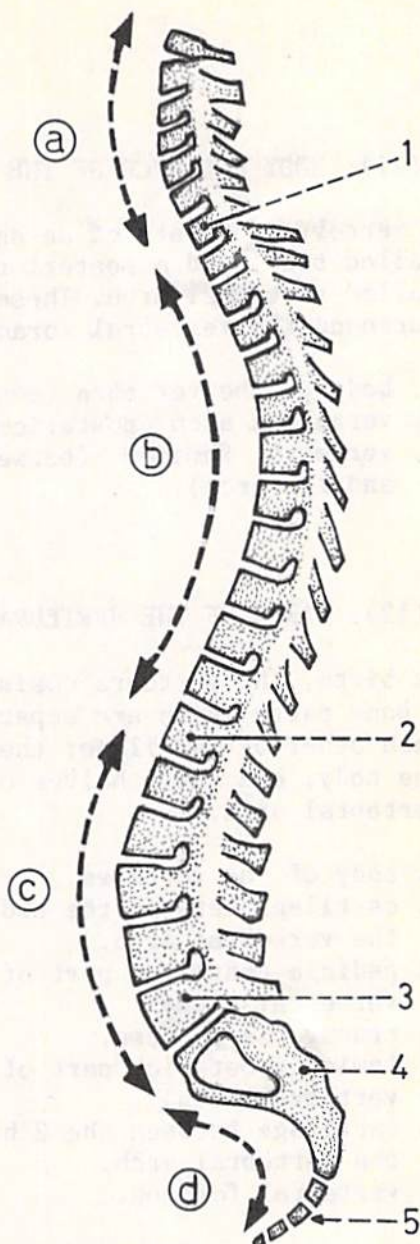


Fig.(10): CURVATURE OF THE VERTEBRAL COLUMN IN THE FOETUS

The foetal vertebral column is concave forwards in all of its regions.

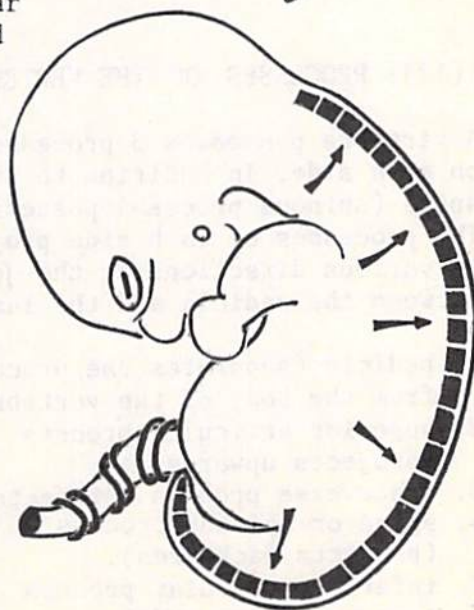


Fig.(11): BODY AND ARCH OF THE VERTEBRA

A vertebra consists of an anterior part called body, and a posterior curved part called vertebral arch. These 2 parts surround the vertebral foramen.

1. body of the vertebra (anterior).
2. vertebral arch (posterior).
3. vertebral foramen (between the body and the arch).

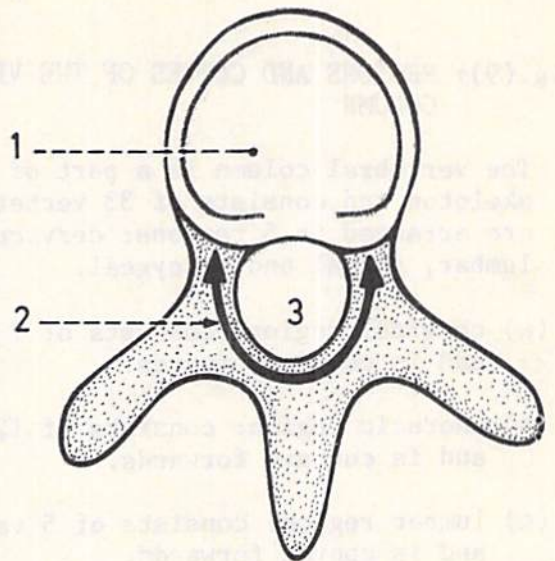


Fig.(12): PARTS OF THE VERTEBRA AT BIRTH

At birth, the vertebra consists of 3 bony parts which are separated from each other by cartilage; these are the body, and the 2 halves of the vertebral arch.

1. body of the vertebra.
2. cartilage between the body and the vertebral arch.
3. pedicle (anterior part of the vertebral arch).
4. transverse process.
5. lamina (posterior part of the vertebral arch).
6. cartilage between the 2 halves of the vertebral arch.
7. vertebral foramen.

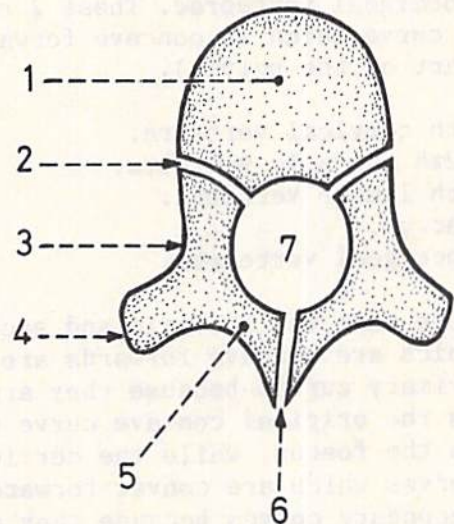


Fig.(13): PROCESSES OF THE VERTEBRA

A vertebra possesses 3 processes on each side, in addition to the spine (spinous process) posteriorly. The processes on each side project in various directions at the junction between the pedicle and the lamina.

1. pedicle (separates the processes from the body of the vertebra).
2. superior articular process (projects upwards).
3. transverse process (projects laterally).
4. spine or spinous process (projects backwards).
5. inferior articular process (projects downwards).

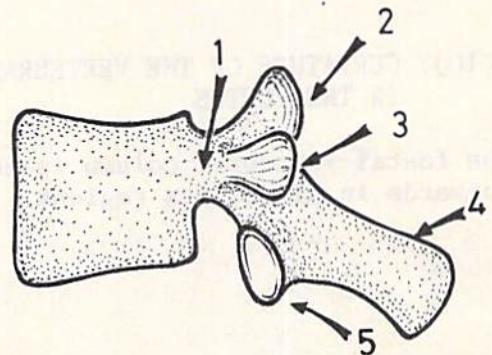


Fig.(14): PARTS OF THE VERTEBRA
(superior view)

1. body of the vertebra.
2. pedicle (a short bar of bone which extends backwards from the body).
3. superior articular process (bears the superior articular facet; the process projects upwards at the junction between the pedicle and lamina).
4. lamina (extends from the pedicle to the spine).
5. spine (projects backwards at the meeting of the 2 laminae).

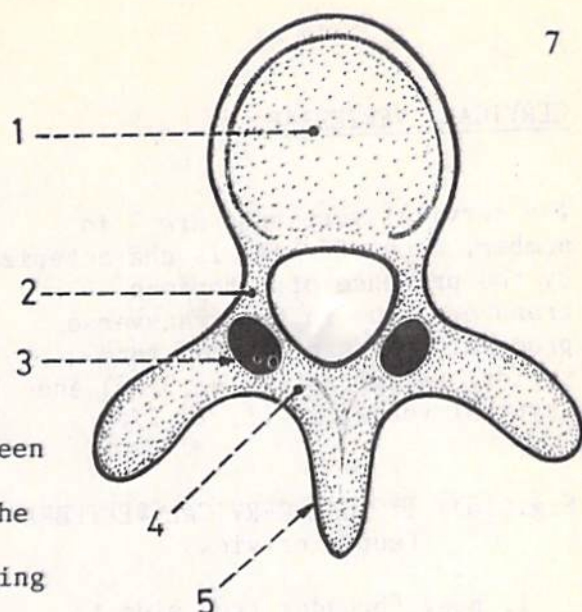
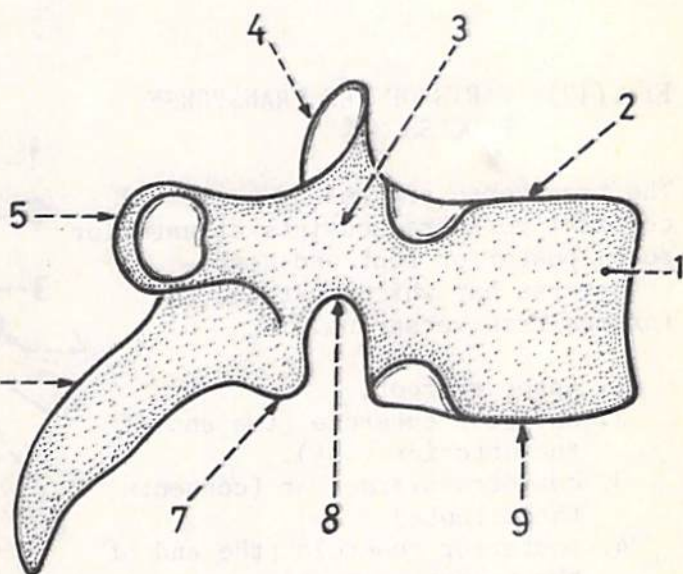


Fig.(15): PARTS OF THE VERTEBRA
(side view)

1. body of the vertebra (directed anteriorly).
2. upper surface of the body.
3. pedicle (its upper and lower borders are concave and called vertebral notches).
4. superior articular process (bears the superior articular facet).
5. transverse process (projects laterally at the junction between the pedicle and the lamina).
6. spine.
7. inferior articular process (bears the inferior articular facet; the process projects downwards in line with the superior articular process).
8. lower border of the pedicle which is deeply concave to form the lower vertebral notch.
9. lower surface of the body.



* Note that in the articulated column, the vertebral notches of contiguous vertebrae bound the intervertebral foramina.

CERVICAL VERTEBRAE

The cervical vertebrae are 7 in number, each of which is characterized by the presence of a foramen transversarium in the transverse process. They are divided into typical vertebrae (3, 4, 5, 6) and atypical vertebrae (1, 2, 7).

Fig.(16): TYPICAL CERVICAL VERTEBRA (superior view)

1. body (broader from side to side than from before backwards).
2. foramen transversarium (in the transverse process).
3. transverse process.
4. superior articular facet (directed upwards and backwards).
5. vertebral foramen (triangular in outline).
6. spine (short and bifid).

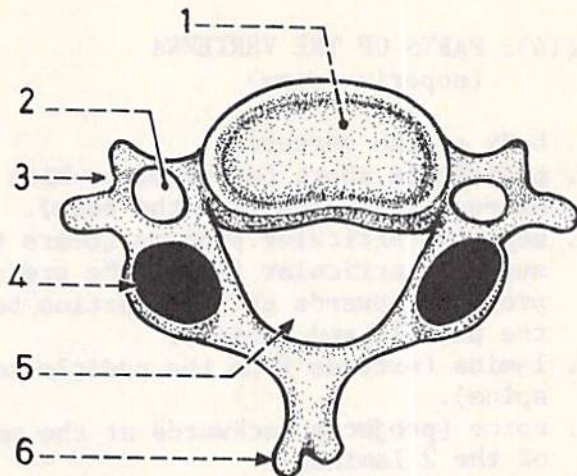
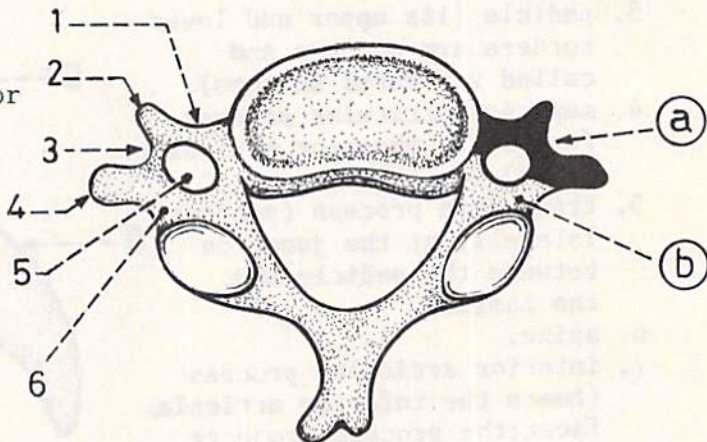


Fig.(17): PARTS OF THE TRANSVERSE PROCESS

The transverse process of a typical cervical vertebra consists of anterior root, posterior root and costotransverse bar which surround the foramen transversarium.

1. anterior root.
2. anterior tubercle (the end of the anterior root).
3. costotransverse bar (connects the 2 roots).
4. posterior tubercle (the end of the posterior root).
5. foramen transversarium.
6. posterior root.



* Note that the transverse process of the cervical vertebra is formed of a part homologous with a rib and is called the costal element, and a part homologous with the transverse process of a thoracic vertebra. The costal element (a) consists of the anterior root with its tubercle, costotransverse bar and the posterior tubercle, while the transverse process proper (b) consists of the posterior root without its tubercle.

Fig.(18): TYPICAL CERVICAL VERTEBRAE
ARTICULATING TOGETHER
(anterior view)

1. lips projecting upwards from the sides of the upper surface of the body of the vertebra.
2. arrows representing the courses of the cervical nerves as they emerge from the intervertebral foramina and pass on the grooved upper surfaces of the transverse processes.
3. body of the vertebra (has a concave upper surface).

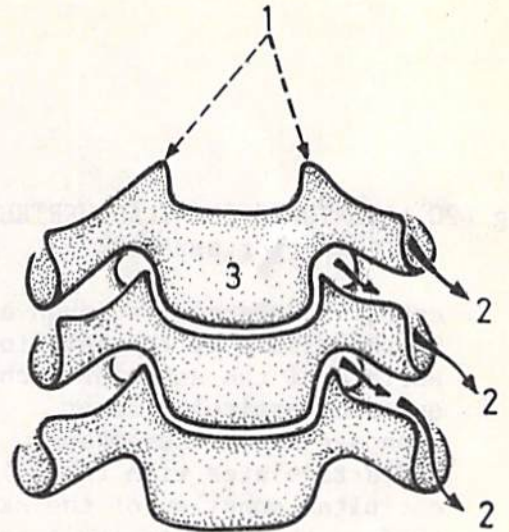
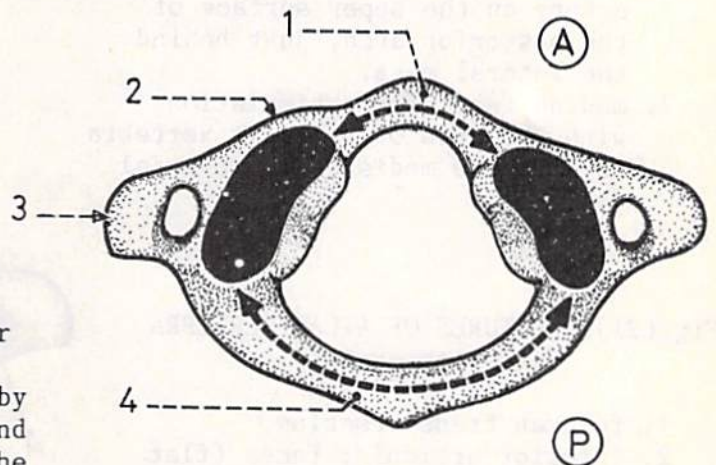


Fig.(19): ATLAS VERTEBRA
(1st cervical vertebra)

It is ring-like and consists of 2 lateral masses and 2 arches (anterior and posterior).

1. anterior arch (shorter than the posterior arch and forms $\frac{1}{5}$ of the ring).
2. lateral mass (bears the upper and lower articular facets).
3. transverse process (pierced by the foramen transversarium and is attached to the side of the lateral mass).
4. posterior arch (longer than the anterior arch and forms $\frac{2}{5}$ of the ring).



* Note that the atlas vertebra has neither a body nor a spine.

Fig.(20): FEATURES OF ATLAS VERTEBRA
(superior aspect)

1. anterior tubercle (a rough area in the middle of the anterior surface of the anterior arch).
2. superior articular facet (concave and kidney-shaped and articulates with the occipital condyle of the skull to form the atlanto-occipital joint).
3. foramen transversarium.
4. transverse process (not divided into anterior and posterior tubercles).
5. posterior tubercle (a rough area in the middle of the posterior surface of the posterior arch replacing the spine).
6. a wide groove for the vertebral artery on the upper surface of the posterior arch, just behind the lateral mass.
7. median facet for articulation with the dens of the axis vertebra to form the median atlanto-axial joint.

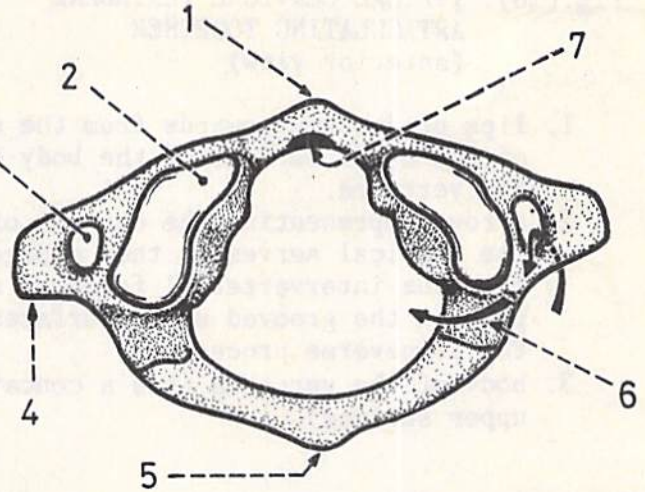
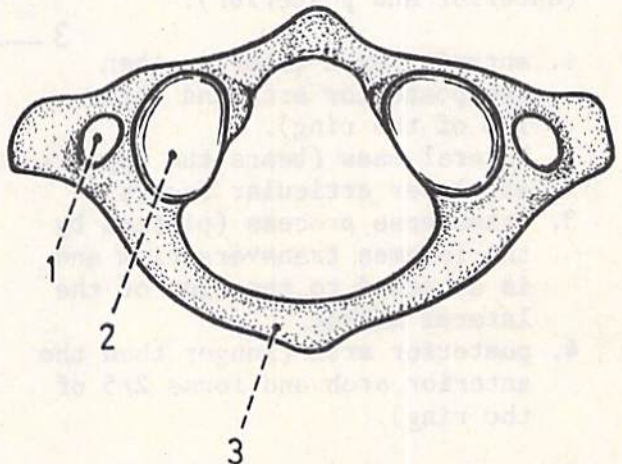


Fig.(21): FEATURES OF ATLAS VERTEBRA
(inferior aspect)

1. foramen transversarium.
2. inferior articular facet (flat and circular for articulation with the superior articular facet of the axis vertebra to form the lateral atlanto-axial joint).
3. posterior arch.



- * To put the atlas vertebra in the anatomical position, note the following:
- anteriorly : the short anterior arch.
 - posteriorly : the longer posterior arch.
 - superiorly : the concave kidney-shaped articular facet.
 - inferiorly : the flat circular articular facet.

Fig.(22): AXIS VERTEBRA
(2nd cervical vertebra)
(superior aspect)

The axis vertebra is characterized by the dens which projects upwards from its body.

1. dens (odontoid process).
2. superior articular facet (flat and circular and articulates with the inferior facet of the atlas vertebra).
3. transverse process (small and unsplit).
4. inferior articular process.
5. lamina.
6. spine (large, strong and bifid).
7. vertebral foramen.
8. body of the vertebra.
9. foramen transversarium (directed upwards and laterally).

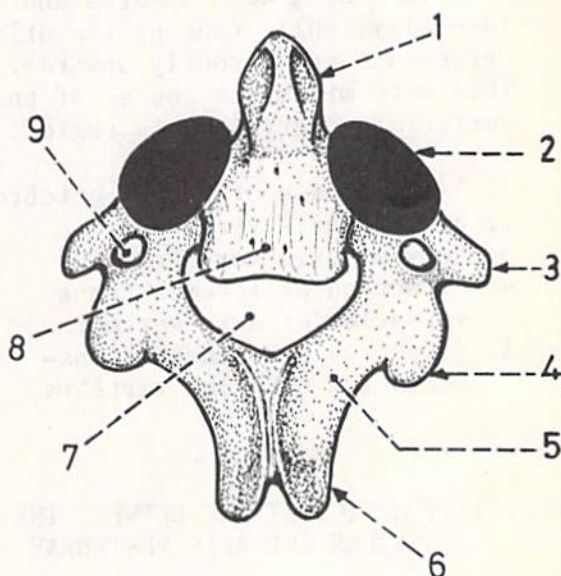


Fig.(23): AXIS VERTEBRA
(side view)

1. dens (projects upwards from the body of the vertebra to lie just behind the anterior arch of the atlas).
2. oval articular facet on the anterior surface of the dens (articulates with the facet on the posterior surface of the anterior arch of the atlas to form the median atlanto-axial joint).
3. superior articular surface.
4. body of the axis.
5. foramen transversarium.
6. transverse process.
7. inferior articular process (bears the inferior articular facet which faces downwards and forwards).
8. spine.

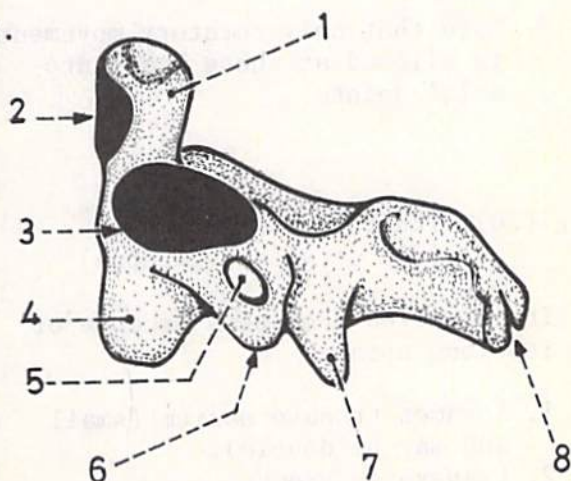


Fig.(24): DIRECTION OF THE FORAMINA TRANSVERSARIA OF THE AXIS AND ATLAS VERTEBRAE

The foramen transversarium of the axis vertebra faces upwards and laterally, while that of the atlas vertebra faces directly upwards. This determines the course of the vertebral artery in this region.

1. lateral mass of atlas vertebra.
2. dens of axis vertebra.
3. body of axis vertebra.
4. direction of foramen transversarium of axis vertebra.
5. direction of foramen transversarium of atlas vertebra.

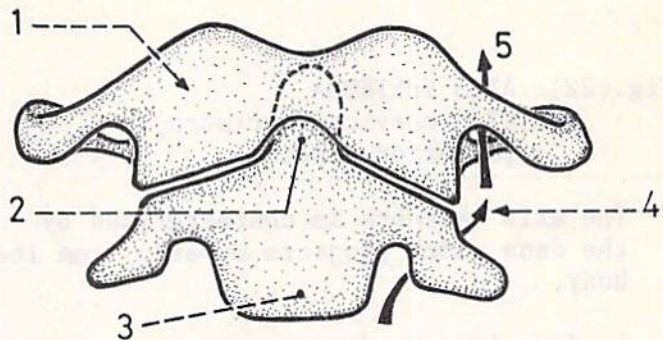


Fig.(25): ARTICULATIONS BETWEEN THE ATLAS AND AXIS VERTEBRAE

1. median atlanto-axial joint (between the front of the dens and the back of the anterior arch of the atlas).
2. lateral atlanto-axial joint (between the inferior facet of the atlas and the superior facet of the axis).

* Note that only rotatory movement is allowed at these 2 atlanto-axial joints.

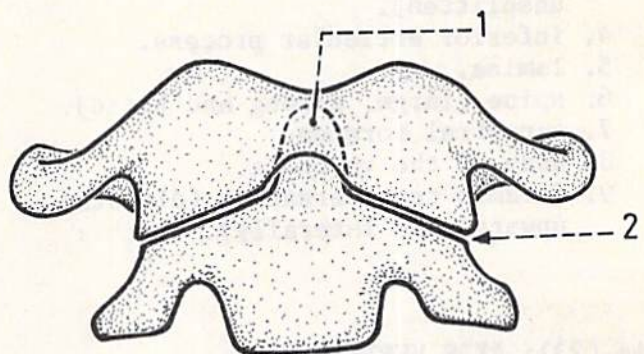
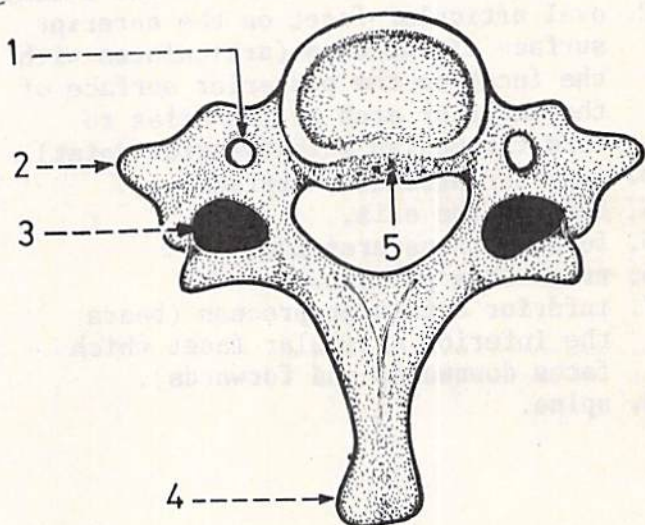


Fig.(26): VERTEBRA PROMINENS (7th cervical vertebra)

It is called prominens because of its long spine.

1. foramen transversarium (small and may be double).
2. transverse process.
3. superior articular facet.
4. spine (long, horizontal and ends in a tubercle).
5. foramina for the basivertebral veins on the posterior surface of the body.



THORACIC VERTEBRAE

These are 12 in number and are characterized by the presence of costal facets for articulations with the ribs. The vertebrae from 2nd to 8th are typical, while the 1st, 9th, 10th, 11th and 12th are atypical.

Fig.(27): TYPICAL THORACIC VERTEBRA (side view)

1. superior articular facet (faces backwards and slightly laterally).
2. costal facet on the anterior aspect of the transverse process (articulates with the facet on the tubercle of the rib).
3. spine (long with pointed tip and is directed downwards and backwards).
4. inferior articular process (bears a facet which faces forwards and slightly medially).
5. costal demifacet for the head of a rib.
6. body.
7. costal demifacet for the head of a rib.

* Note that the 2 demifacets on the side of the body articulate with the heads of 2 successive ribs.

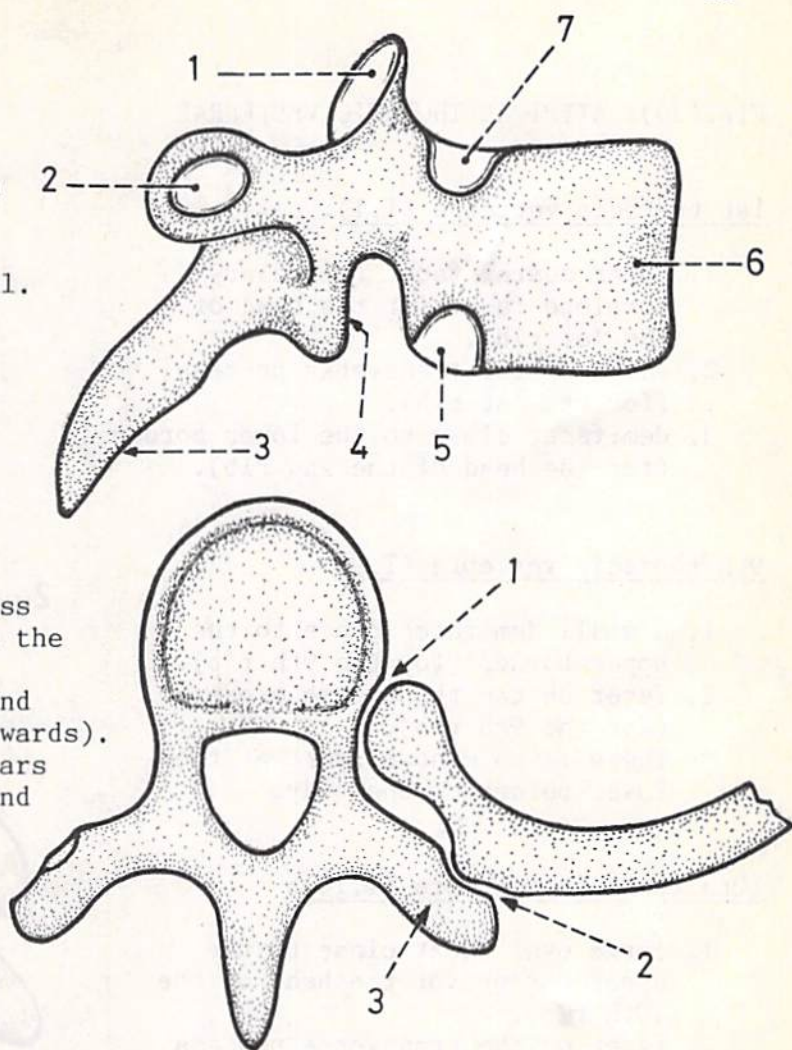


Fig.(28): ARTICULATION OF THE RIB WITH THE THORACIC VERTEBRA

1. joint between the head of the rib and the side of the body of the vertebra.
2. joint between the tubercle of the rib and the front of the transverse process of the vertebra.
3. transverse process.

Fig.(29): DIRECTION OF THORACIC SPINES

1. spines from 1st to 4th: oblique.
2. spines from 5th to 8th: vertical.
3. spines from 9th to 12th: oblique.

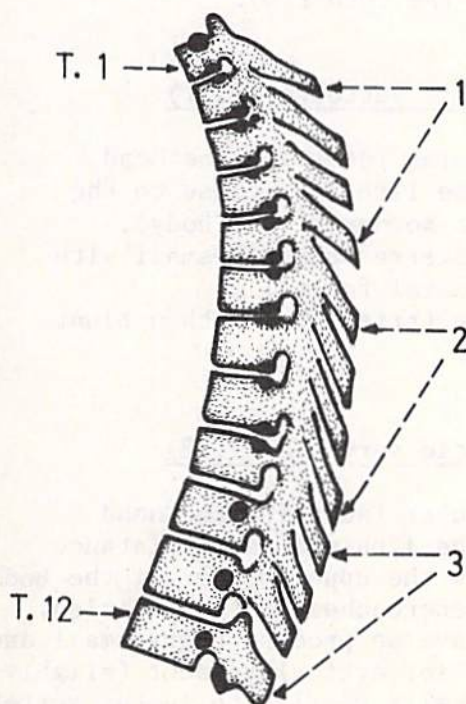
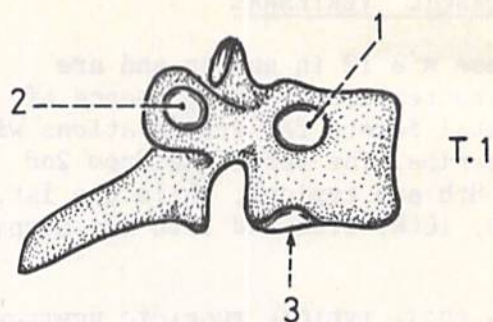


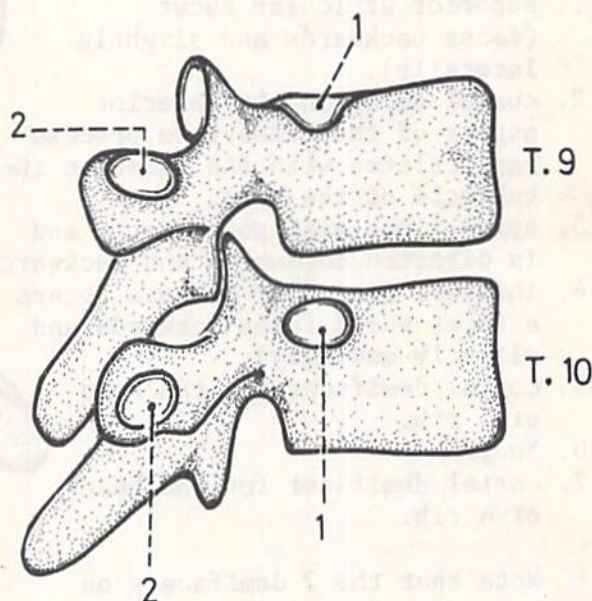
Fig.(30): ATYPICAL THORACIC VERTEBRAE

1st thoracic vertebra (T.1):

1. upper costal facet (circular complete facet for the head of the 1st rib).
2. facet on the transverse process (for the 1st rib).
3. demifacet close to the lower border (for the head of the 2nd rib).

9th thoracic vertebra (T.9):

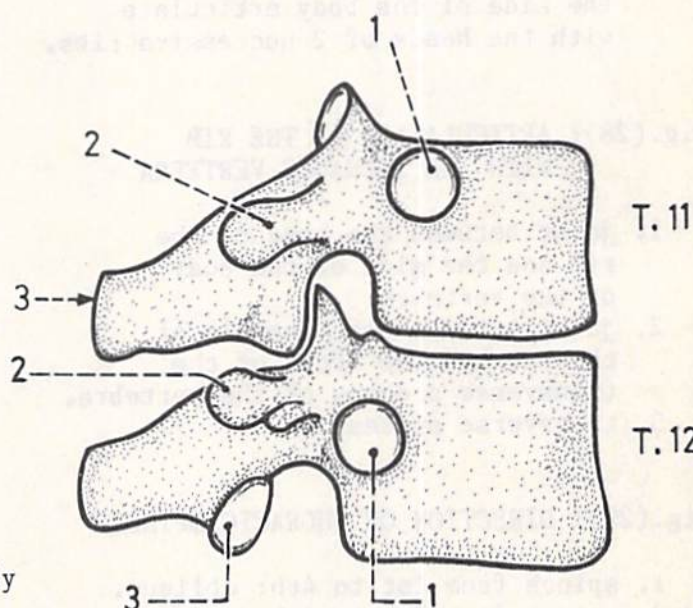
1. a small demifacet close to the upper border (for the 9th rib).
 2. facet on the transverse process (for the 9th rib).
- * There is no costal facet at the lower border of the body.

10th thoracic vertebra (T.10):

1. large oval facet close to the upper border (for the head of the 10th rib).
2. facet on the transverse process (for the 10th rib).

11th thoracic vertebra (T.11):

1. circular facet for the head of the 11th rib (close to the upper border of the body).
2. transverse process (small with no costal facet).
3. spine (triangular with a blunt tip).

12th thoracic vertebra (T.12):

1. circular facet for the head of the 12th rib (some distance below the upper border of the body and encroaches on the pedicle).
2. transverse process (very small and has no facet).
3. inferior articular facet (slightly convex and is directed forwards and laterally similar to lumbar vertebrae).

LUMBAR VERTEBRAE

A lumbar vertebra differs from both the cervical and thoracic vertebrae in having neither foramina transversaria nor costal facets.

Fig.(31): LUMBAR VERTEBRA
(superior aspect)

1. superior articular facet (concave and faces medially and backwards).
2. mamillary process (an elevation on the posterior border of the superior facet).
3. spine (quadrangular and horizontal).
4. accessory process (a small elevation at the postero-inferior part of the root of the transverse process).
5. inferior articular process (bears the inferior articular facet which is convex and faces laterally and forwards).
6. transverse process (thin and long with no costal facet).
7. body (large and broader from side to side).

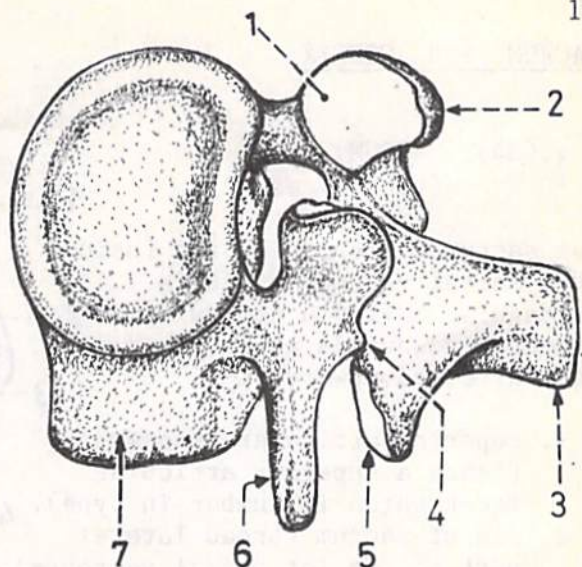


Fig.(32): LUMBAR VERTEBRA
(side view)

1. superior articular process.
2. mamillary process.
3. transverse process.
4. spine.
5. accessory process (may be difficult to identify).
6. inferior articular facet (on the inferior articular process).
7. deep inferior vertebral notch.

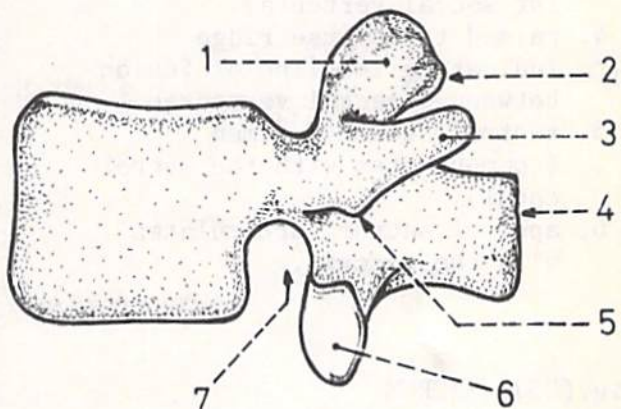
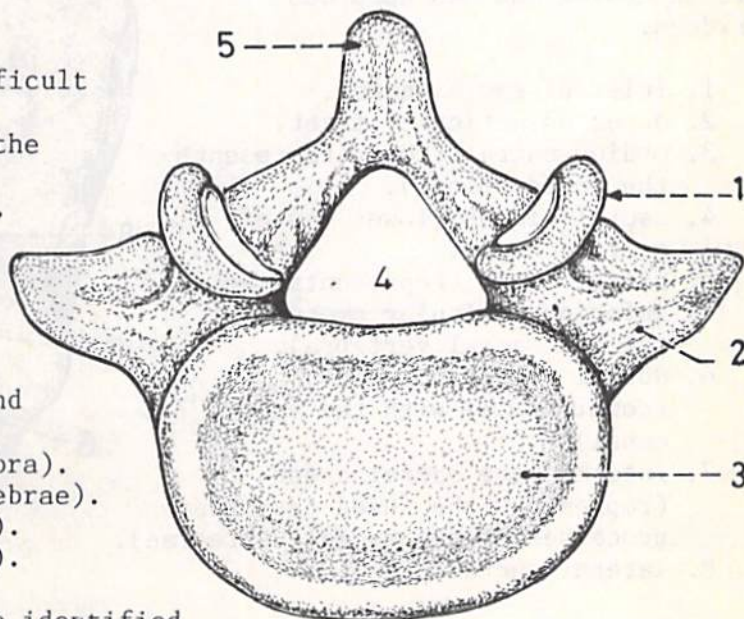


Fig.(33): 5th LUMBAR VERTEBRA

1. superior articular process.
2. transverse process (massive and encroaches on the pedicle and side of the body of the vertebra).
3. body (the largest of all vertebrae).
4. vertebral foramen (triangular).
5. spine (small with rounded tip).



* The 5th lumbar vertebra can be identified mainly from its transverse process.

SACRUM AND COCCYX

Fig.(34): SACRUM
(ventral aspect)

The sacrum is formed by the fusion of 5 sacral vertebrae. It is triangular having a narrow apex directed downwards and a broad base directed upwards.

1. superior articular process (bears a superior articular facet which is lumbar in type).
2. ala of sacrum (broad lateral part of the 1st sacral vertebra).
3. sacral promontory (projecting anterior edge of the body of the 1st sacral vertebra).
4. raised transverse ridge indicating the line of fusion between 2 sacral vertebrae.
5. ventral sacral foramen (communicates with the sacral canal).
6. apex of sacrum (articulates with the coccyx).

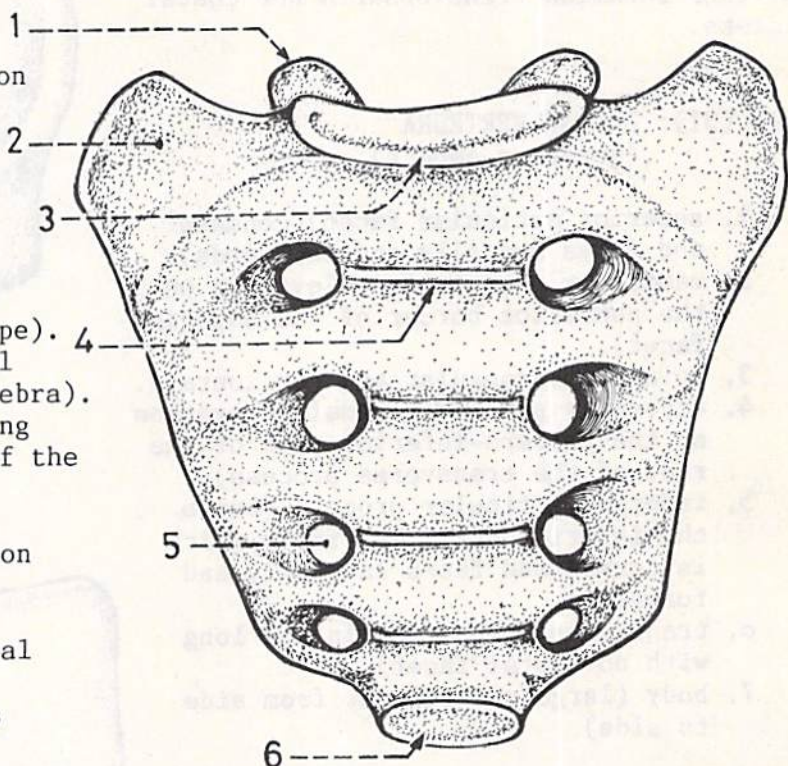
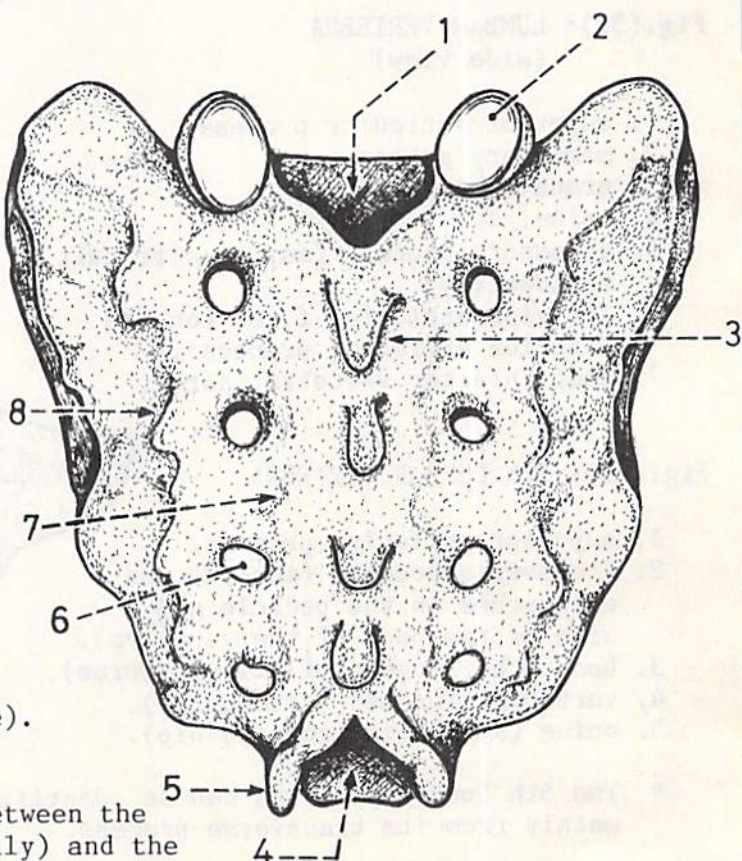


Fig.(35): SACRUM
(dorsal aspect)

It is convex and has numerous ridges.

1. inlet of sacral canal.
2. superior articular facet.
3. median sacral crest (represents the fused spines).
4. sacral hiatus (lower end of sacral canal).
5. sacral cornu (represents the inferior articular process of the 5th sacral vertebra).
6. dorsal sacral foramen (communicates with the sacral canal).
7. intermediate sacral crest (represents the fused articular processes of the sacral vertebrae).
8. lateral sacral crest.



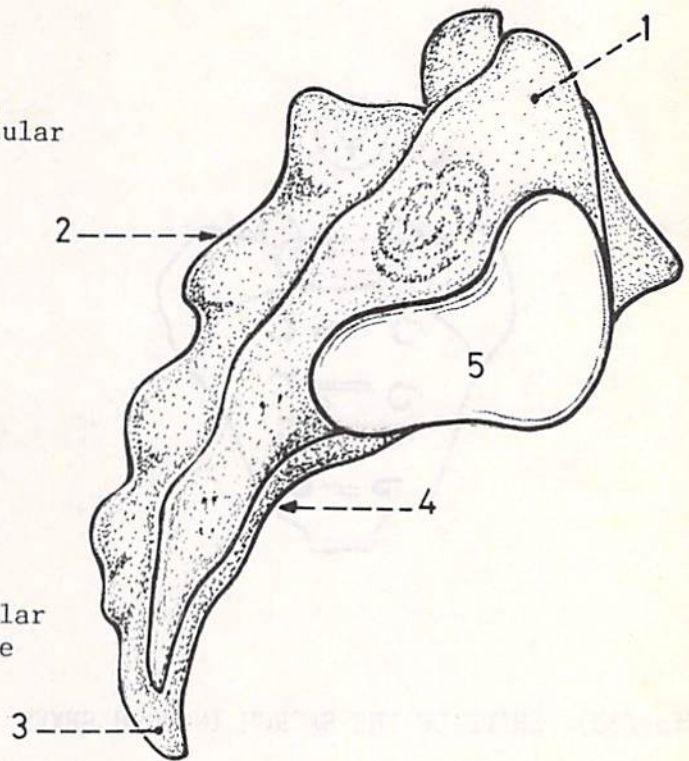
* The dorsal sacral foramina lie between the intermediate sacral crest (medially) and the lateral sacral crest (laterally).

Fig.(36): LATERAL SURFACE OF SACRUM

It is wide above but narrow below, and its upper part bears the auricular surface.

1. base of the sacrum.
2. median sacral crest (on the posterior surface).
3. apex of the sacrum.
4. concave ventral surface of the sacrum.
5. auricular surface (an inverted "L" articular surface which articulates with the auricular surface of the ilium to form the sacro-iliac joint).

- * The vertical limb of the auricular surface extends downwards to the level of the 2nd or 3rd sacral vertebra according to sex.

Fig.(37): BASE OF THE SACRUM
IN BOTH SEXES

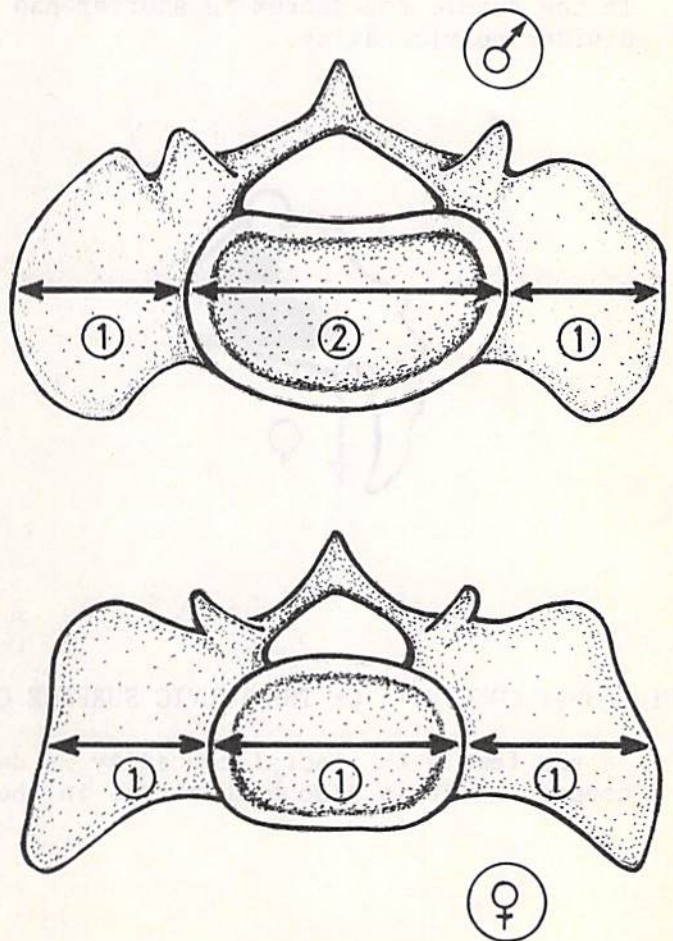
* In the male:

The body of the 1st sacral vertebra forms $\frac{2}{4}$ of the base of the sacrum, while each of the alae forms $\frac{1}{4}$.

* In the female:

The body of the 1st sacral vertebra forms $\frac{1}{3}$ of the base of the sacrum, while each of the alae forms $\frac{1}{3}$.

- * Note that the alae of the sacrum are broader in the female than in the male which provide more width for the pelvic cavity.



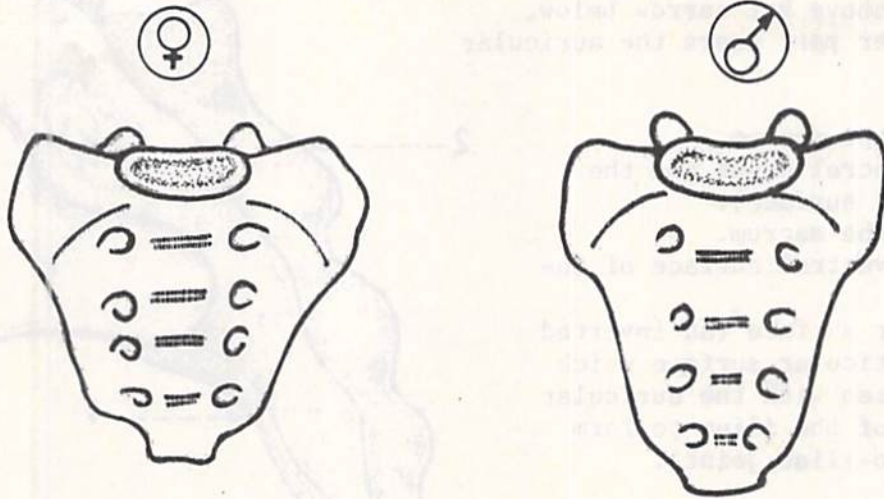


Fig.(38): SHAPE OF THE SACRUM IN BOTH SEXES

In the female the sacrum is shorter and wider than in the male to provide a wider pelvic cavity.



Fig.(39): CONCAVITY OF THE PELVIC SURFACE OF THE SACRUM IN BOTH SEXES

In the female the sacral concavity is deeper than in the male and its deepest point is also higher than in the male.

Fig.(40): AURICULAR SURFACE OF THE SACRUM IN BOTH SEXES

In the female the vertical limb of the auricular surface is shorter than in the male and reaches down to the level of the 2nd sacral vertebra, while in the male it reaches down to the level of the 3rd sacral vertebra.

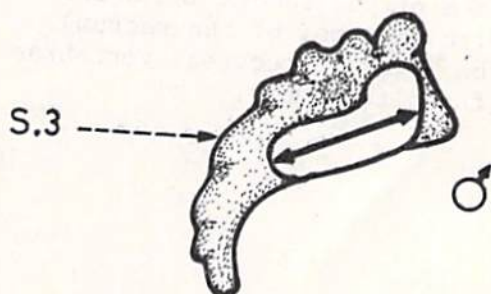
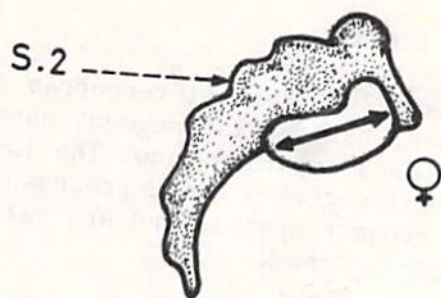
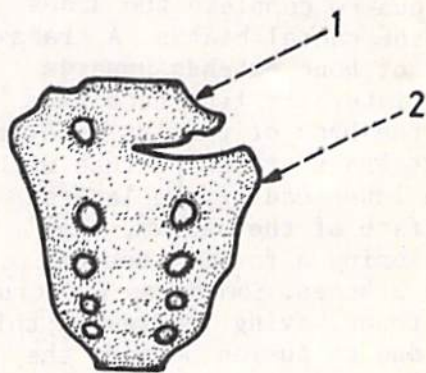


Fig.(41): SACRALIZATION OF 5th LUMBAR VERTEBRA

The sacrum may show variations in the number of its vertebrae. It may consist of 4 vertebrae or 6 vertebrae. If it consists of 6 vertebrae the extra vertebra may be the 1st coccygeal vertebra fused with the apex of the sacrum or the 5th lumbar vertebra fused with its base. Fusion of the 5th lumbar vertebra with the base of the sacrum is usually incomplete and is called sacralization of the 5th lumbar vertebra.



1. 5th lumbar vertebra.
2. base of the sacrum.

Fig.(42): COCCYX

It consists of 4 small vertebrae fused together, but the 1st segment usually exists as a separate bone. The 1st coccygeal vertebra has 2 processes which project upwards and are called coccygeal cornua.

1. coccygeal cornu.
2. 1st coccygeal vertebra (forms the base of the coccyx and articulates with the apex of the sacrum).
3. the lower 3 coccygeal vertebrae (fused together).

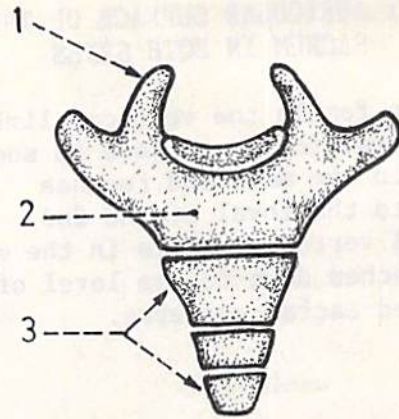
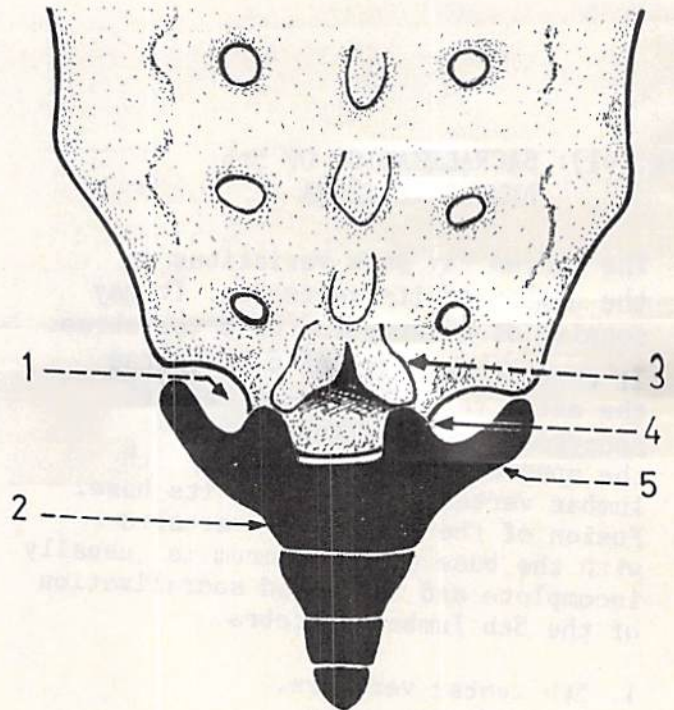


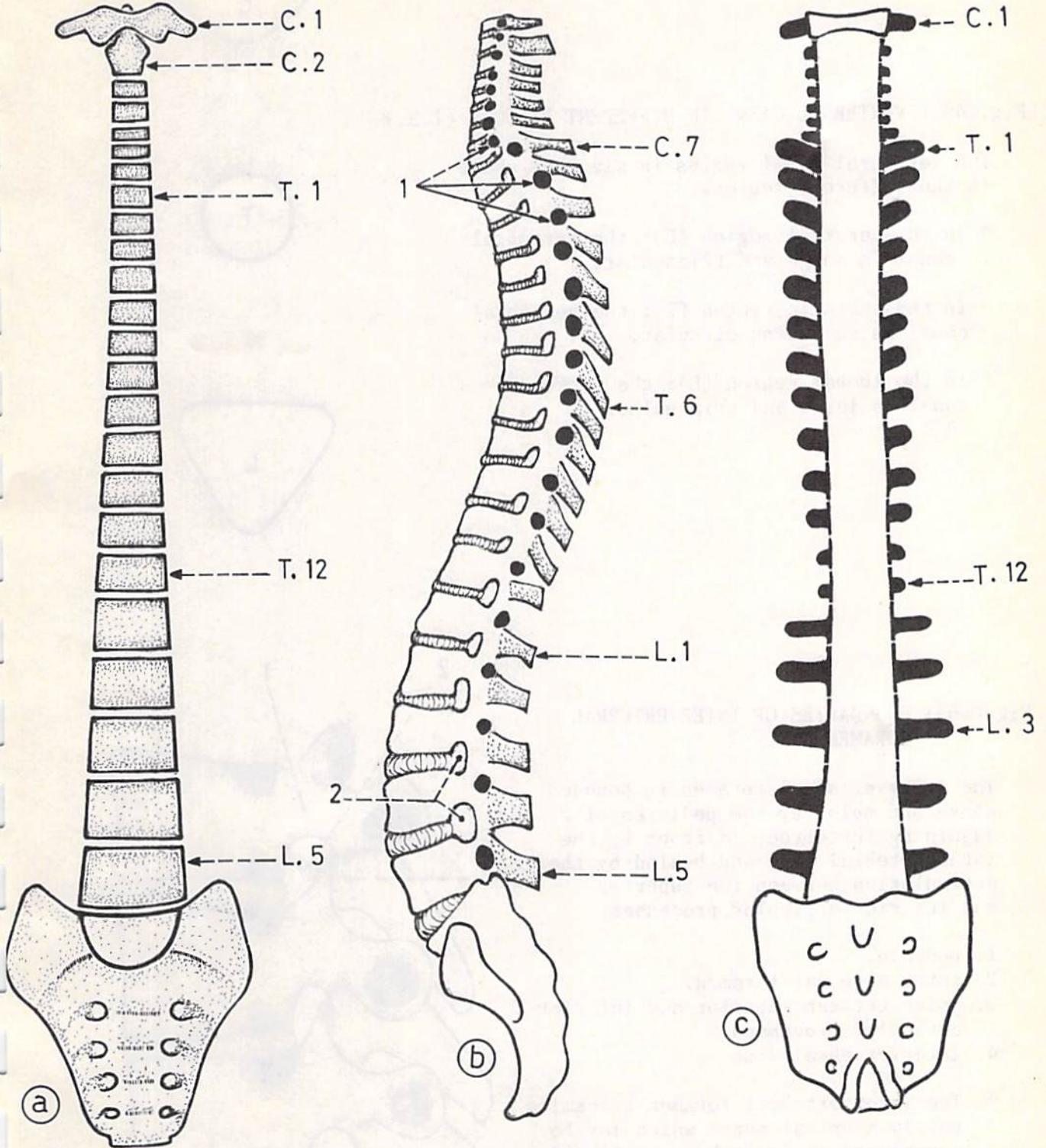
Fig.(43): ARTICULATION OF THE COCCYX WITH THE SACRUM

The body of the 1st coccygeal vertebra articulates (and may be fused) with the 5th sacral vertebra. The coccygeal cornua are directed towards the sacral cornua to complete the sides of the sacral hiatus. A transverse bar of bone extends upwards and laterally from each side of the body of the 1st coccygeal vertebra to reach or fuse with the lower end of the lateral surface of the sacrum, thus enclosing a foramen between the 2 bones. Sometimes a sacrum is found having 5 foramina; this is due to fusion between the sacrum and coccyx and the 5th foramen is the one between the 2 bones, or due to complete sacralization of the 5th lumbar vertebra.



1. foramen between sacrum and coccyx.
2. 1st coccygeal vertebra.
3. sacral cornu.
4. coccygeal cornu.
5. transverse bar of bone.

Fig.(44): VERTEBRAL COLUMN AS A WHOLE



(a) Width of vertebral bodies: increases gradually from above downwards as far as the 5th lumbar vertebra then gradually diminishes.

(b) Spines and intervertebral foramina: the spines vary in direction from one region to the other; the intervertebral foramina increase in size gradually from above downwards.

1. transverse processes.

2. intervertebral foramina.

(c) Transverse dimensions between the tips of the transverse processes: vary from one region to the other and is greatest at C.1, T.1 and L.3.

Fig.(45): VERTEBRAL CANAL IN DIFFERENT REGIONS (T.S.)

The vertebral canal varies in size and shape in the different regions.

- * In the cervical region (C): the vertebral canal is large and triangular.
- * In the thoracic region (T): the vertebral canal is small and circular.
- * In the lumbar region (L): the vertebral canal is large and triangular.

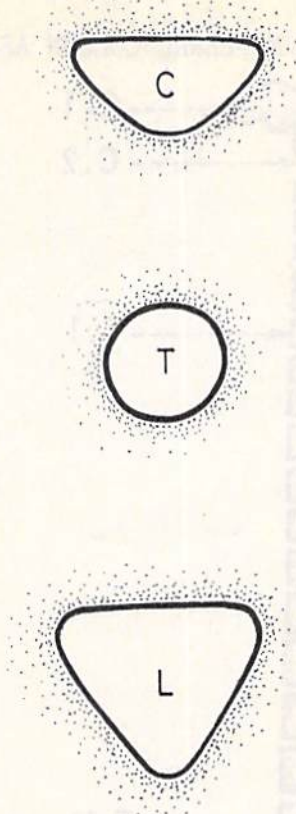


Fig.(46): BOUNDARIES OF INTERVERTEBRAL FORAMEN

The intervertebral foramen is bounded above and below by the pedicles of 2 adjoining vertebrae, in front by the intervertebral disc, and behind by the articulation between the superior and inferior articular processes.

1. pedicle.
2. intervertebral foramen.
3. joint between superior and inferior articular processes.
4. intervertebral disc.

- * The intervertebral foramen transmits mainly a spinal nerve which may be compressed in front by a prolapsed intervertebral disc.

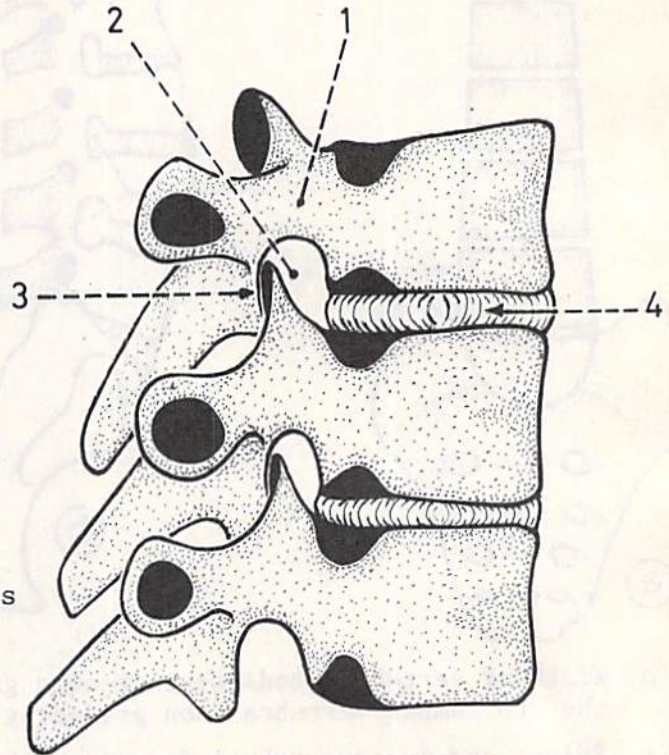


Fig.(47): SURFACE LANDMARKS OF THE VERTEBRAL COLUMN

There are certain spines that are used as surface landmarks; these are the following:

- * C.7 : is readily felt in the lower part of back of the neck (vertebra prominens).
- * T.3 : lies opposite the root of the spine of the scapula.
- * T.7 : lies opposite the inferior angle of the scapula.
- * L.4 : lies opposite the highest point of iliac crest.
- * L.5 : lies opposite the tubercle of iliac crest.
- * S.2 : lies opposite the posterior superior iliac spine.

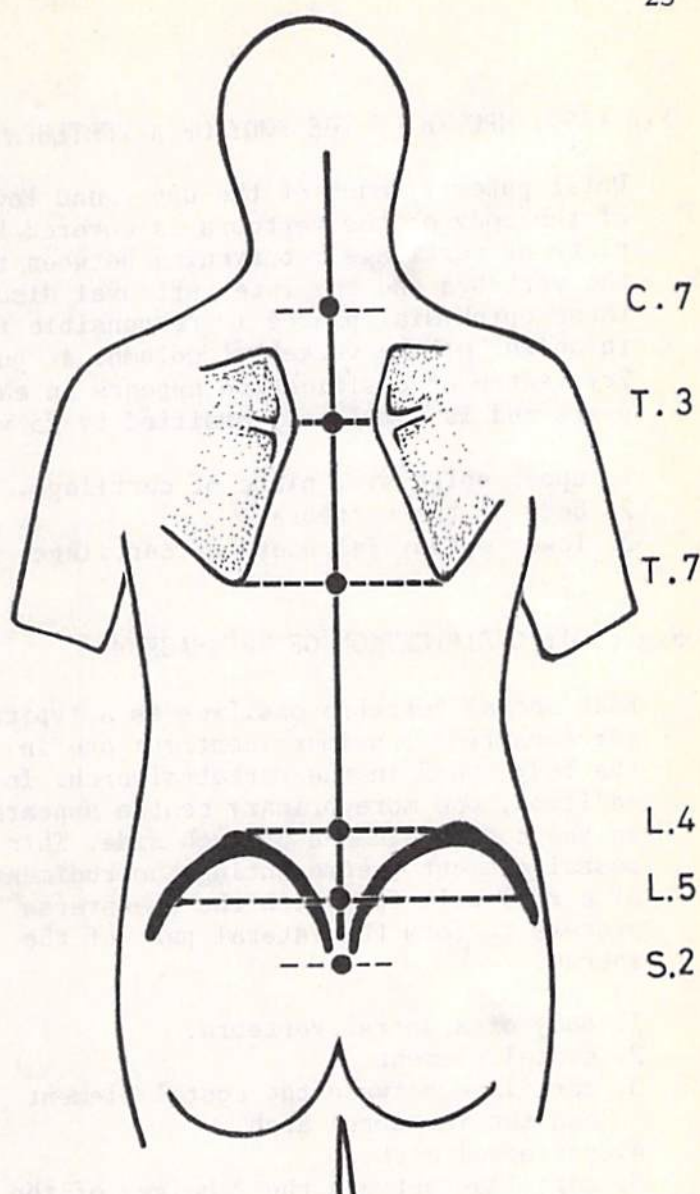


Fig.(48): OSSIFICATION OF A VERTEBRA

A vertebra ossifies from 3 primary centres: one in the body (centrum) and 2 in the vertebral arch, one in each half. These centres appear early during intra-uterine life (8 - 12 weeks).

1. a primary centre in the centrum (body).
2. cartilage between the centrum and vertebral arch (ossifies early during the 1st year after birth).
3. a primary centre in a half of the vertebral arch.
4. cartilage between the 2 halves of vertebral arch (ossifies from 1st to 6th years according to region; failure of its ossification results in spina bifida).
5. the primary centre in the arch spreads into the various processes.

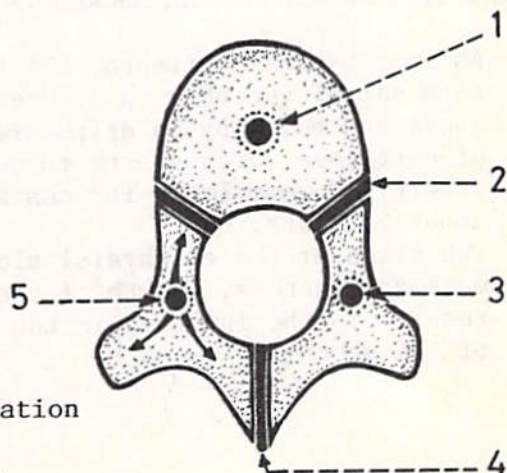
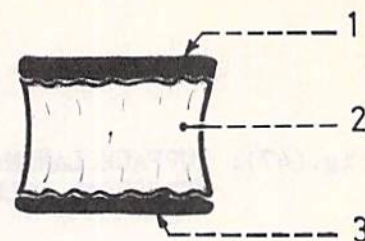


Fig.(49): GROWTH OF THE BODY OF A VERTEBRA

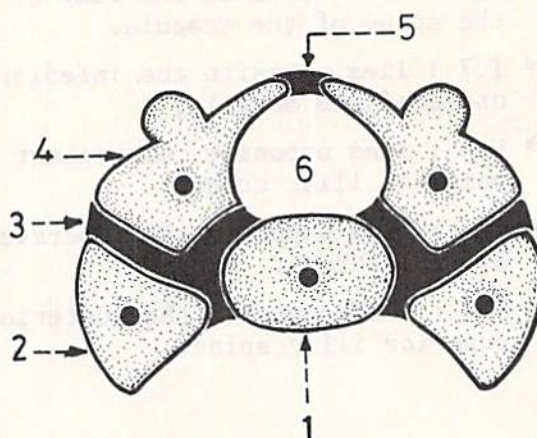
Until puberty, each of the upper and lower surfaces of the body of the vertebra is covered by an epiphysial plate of cartilage intervening between the body of the vertebra and the intervertebral disc. Growth of these epiphysial plates is responsible for the increase in height of the vertebral column. At puberty, a 2ry centre of ossification appears in each epiphysial plate and is completely ossified by 25 years.



1. upper epiphysial plate of cartilage.
2. body of the vertebra.
3. lower epiphysial plate of cartilage.

Fig.(50): OSSIFICATION OF THE SACRUM

Each sacral vertebra ossifies as a typical vertebra from 3 primary centres: one in the body and 2 in the vertebral arch. In addition, one more primary centre appears in the costal element on each side. This costal element (representing the rudiment of a rib) will fuse with the transverse process to form the lateral part of the sacrum.

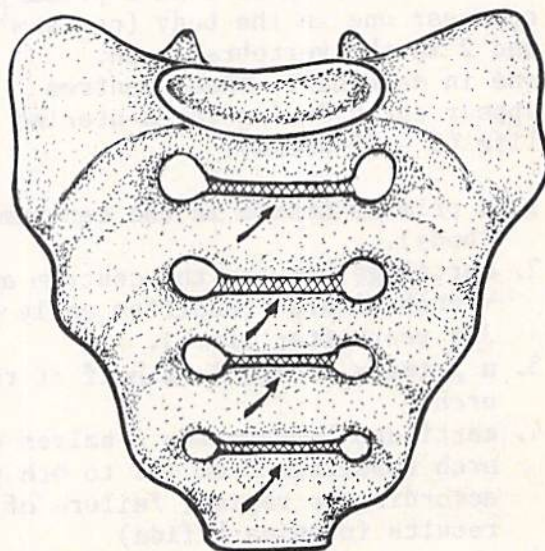


1. body of a sacral vertebra.
2. costal element.
3. cartilage between the costal element and the vertebral arch.
4. vertebral arch.
5. cartilage between the 2 halves of the vertebral arch.

Fig.(51): GROWTH OF THE SACRUM IN HEIGHT

As in a typical vertebra, the body of each sacral vertebra is covered from above and below by an epiphysial plate of cartilage which starts to ossify at puberty and completes its ossification by about 25 years.

The sites of the epiphysial plates are marked by arrows. Growth of these plates results in the increase in the height of the sacrum.



JOINTS OF THE VERTEBRAL COLUMN

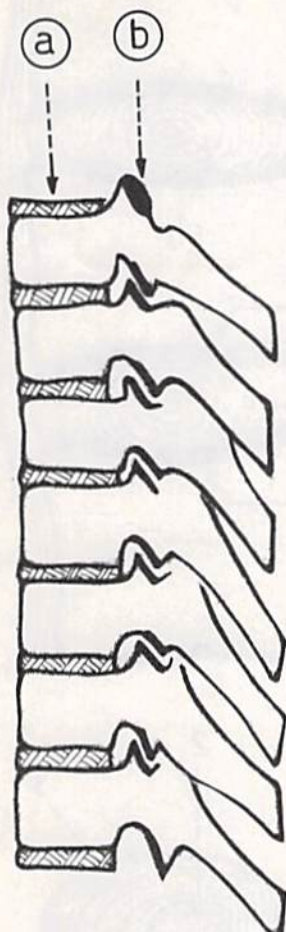


Fig.(52): JOINTS BETWEEN THE VERTEBRAE

The vertebrae articulate together by cartilagenous joints represented by the intervertebral discs between the bodies, and by synovial joints between the articular processes. The synovial joints form 2 longitudinal pillars, one on each side of the midline.

(a) intervertebral discs between the bodies of the vertebrae.

(b) synovial joints between the articular processes.

* Note that the intervertebral foramina lie between the discs (in front) and the synovial joints (behind).

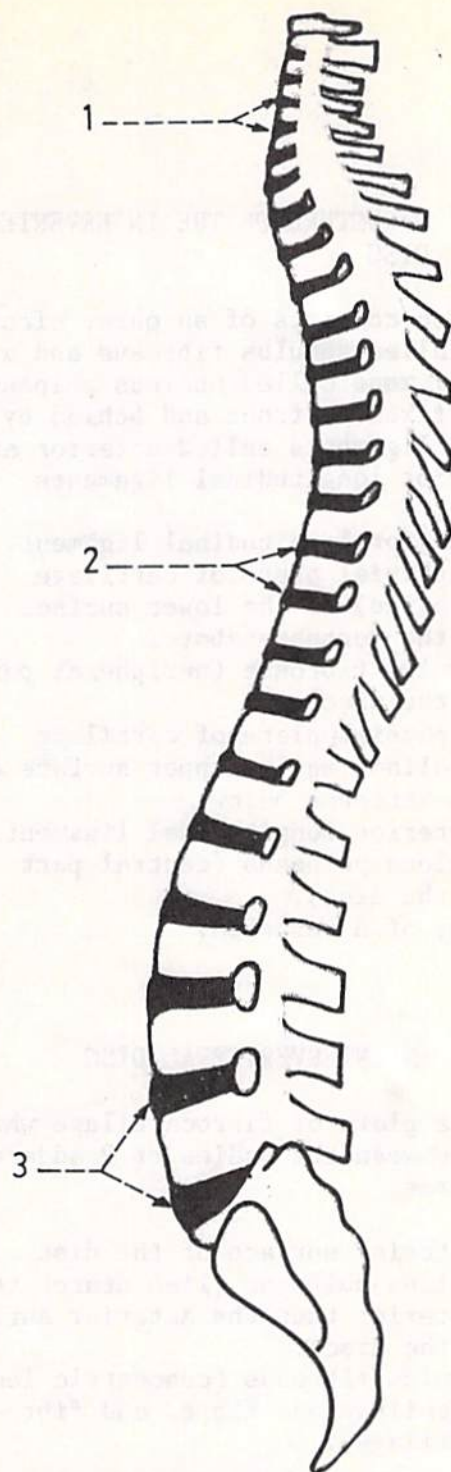


Fig.(53): INTERVERTEBRAL DISCS

The discs when added together form $\frac{1}{5}$ of the whole length of the vertebral column. They increase progressively from above downwards.

1. cervical discs : thicker in front than behind.
2. thoracic discs : uniform in thickness.
3. lumbar discs : much thicker in front than behind.

Fig.(54): STRUCTURE OF THE INTERVERTEBRAL DISC

The disc consists of an outer circular zone called annulus fibrosus and a central zone called nucleus pulposus. It is fixed in front and behind by 2 strong ligaments called anterior and posterior longitudinal ligaments.

1. anterior longitudinal ligament.
2. epiphysial plate of cartilage (hyaline) on the lower surface of the vertebra above.
3. annulus fibrosus (peripheral part of the disc).
4. epiphysial plate of cartilage (hyaline) on the upper surface of the vertebra below.
5. posterior longitudinal ligament.
6. nucleus pulposus (central part of the disc).
7. body of a vertebra.

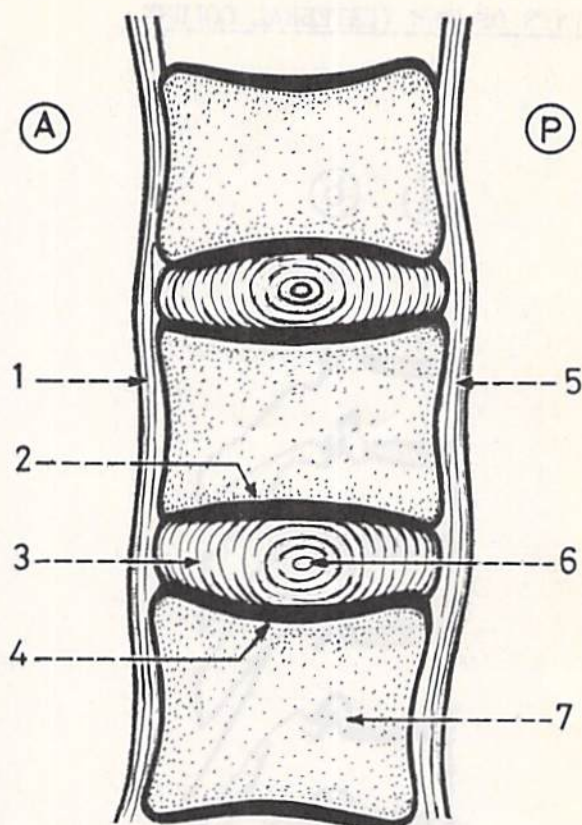


Fig.(55): AN INTERVERTEBRAL DISC

It is a plate of fibrocartilage which lies between the bodies of 2 adjacent vertebrae.

1. posterior surface of the disc.
2. nuclues pulposus (lies nearer the posterior than the anterior surface of the disc).
3. annulus fibrosus (concentric laminae of collagenous fibres and fibrocartilage).

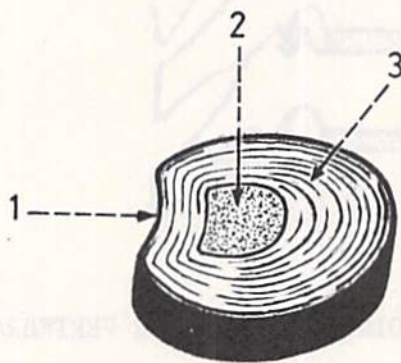


Fig.(56): PROLAPSE OF THE NUCLEUS PULPOSUS

This occurs through degenerated annulus fibrosus and usually takes place postero-laterally towards the intervertebral foramen where the spinal nerve may be compressed.

1. spinal cord.
2. prolapsed nucleus pulposus.
3. spinal nerve (compressed).
4. annulus fibrosus.

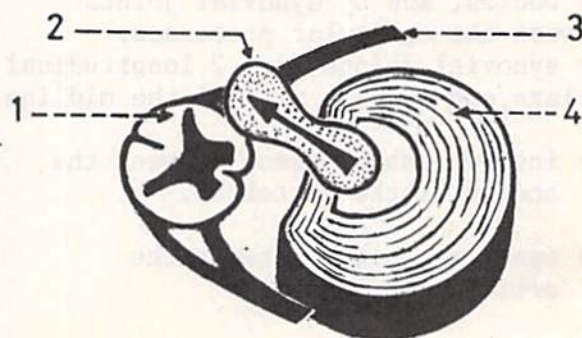


Fig.(57): JOINTS OF THE ARTICULAR PROCESSES

These are synovial joints of the plane variety between the adjacent facets of the superior and inferior articular processes. They form 2 longitudinal pillars, one on each side of the midline.

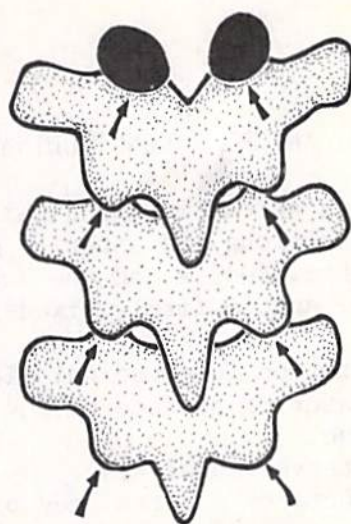
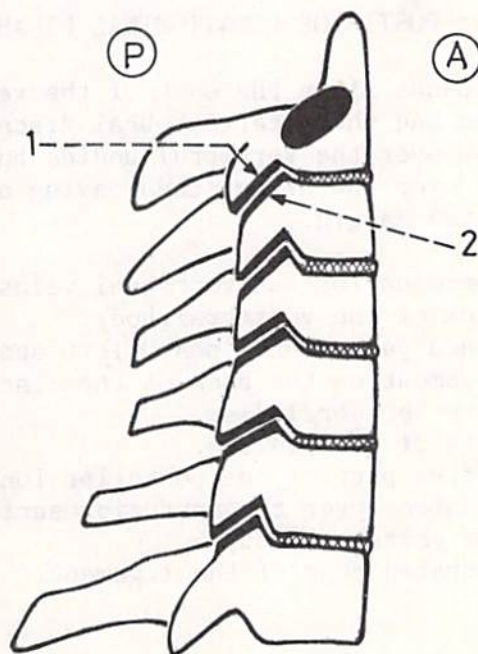


Fig.(58): JOINTS OF THE ARTICULAR PROCESSES
(side view)

The articulating surfaces of these joints are flat. The direction of these surfaces varies from one region to the other.

1. inferior articular facet of the vertebra above.
2. superior articular facet of the vertebra below.



LIGAMENTS OF THE VERTEBRAL COLUMN

Fig.(59): ANTERIOR LONGITUDINAL LIGAMENT

It is a strong longitudinal ligament which extends along the anterior surfaces of the vertebral bodies and the intervertebral discs, and is firmly fixed to them.

1. anterior longitudinal ligament.
2. posterior surface of the intervertebral disc.
3. intervertebral disc.
4. demifacet for the head of a rib on the side of a vertebral body.

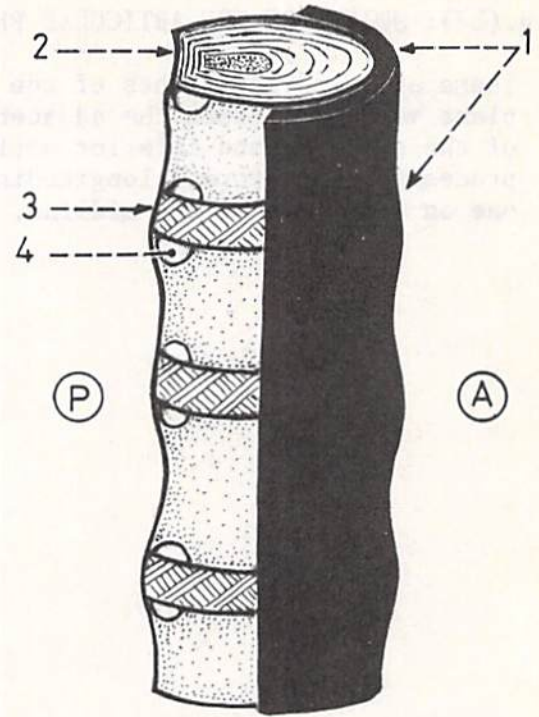


Fig.(60): POSTERIOR LONGITUDINAL LIGAMENT

It extends along the back of the vertebral bodies and the intervertebral discs. It is narrow over the vertebral bodies but broad over the discs, thus having a serrated margin.

1. foramina for basivertebral veins on the back of the vertebral body.
2. broad part of the posterior longitudinal ligament on the back of the disc.
3. intervertebral disc.
4. site of the pedicle.
5. narrow part of the posterior longitudinal ligament over the posterior surface of the vertebral body.
6. serrated edge of the ligament.

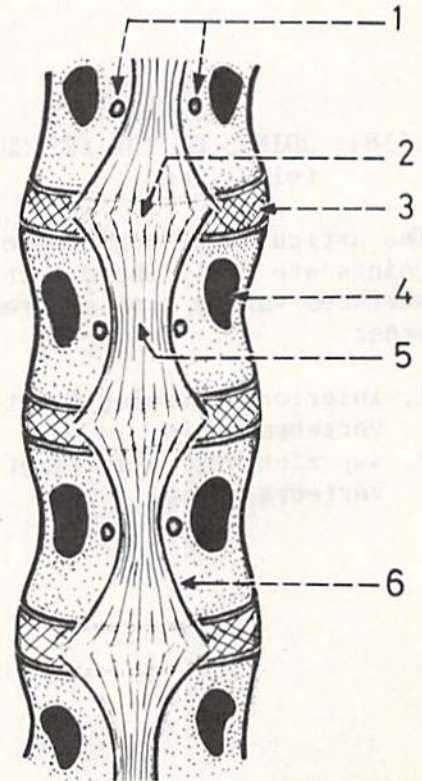


Fig.(61): INTERSPINOUS AND SUPRASPINOUS
LIGAMENTS
(side view)

1. supraspinous ligament: extends between and over the tips of the spines.
2. interspinous ligament: extends between adjacent spines.
3. anterior longitudinal ligament.

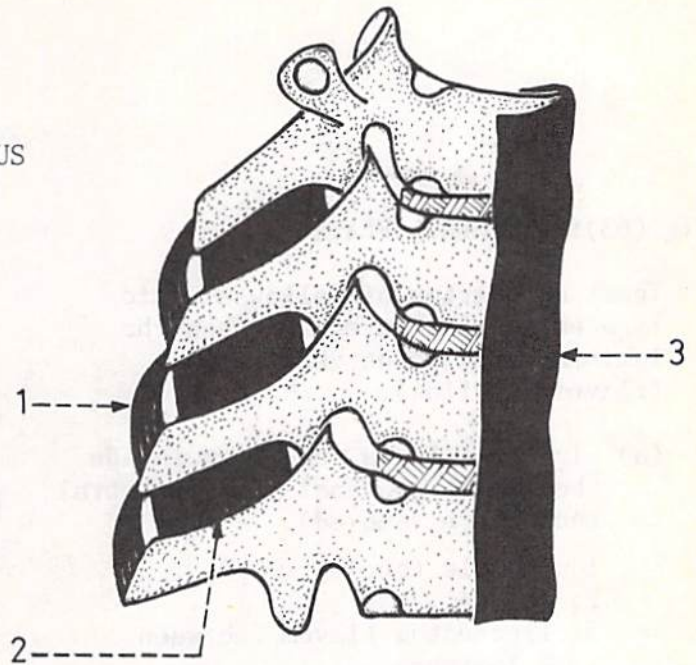


Fig.(62): LIGAMENTUM NUCHAE

It represents the supraspinous ligaments in the cervical region. It extends from the external occipital protuberance and external occipital crest on the back of the skull down to the tip of the 7th cervical vertebra.

1. base of the ligamentum nuchae (attached to the external occipital crest).
2. external occipital protuberance.
3. free posterior edge of the ligamentum nuchae.
4. tip of the 7th cervical spine (gives attachment to the apex of the ligamentum nuchae).
5. interspinous ligament.

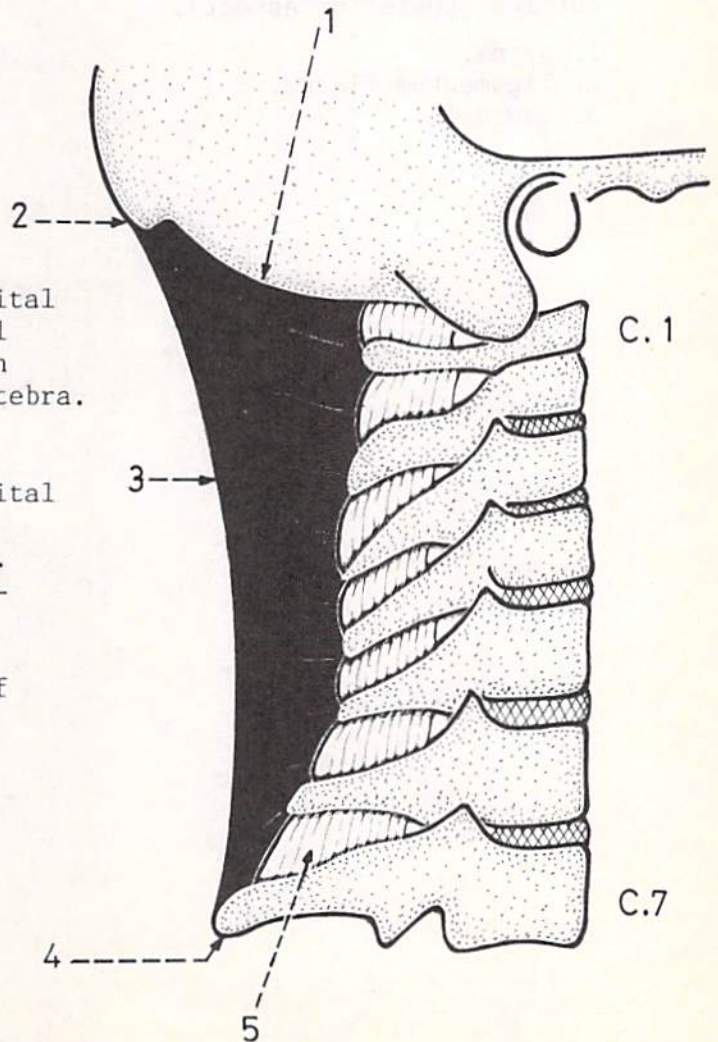


Fig.(63): LIGAMENTA FLAVA

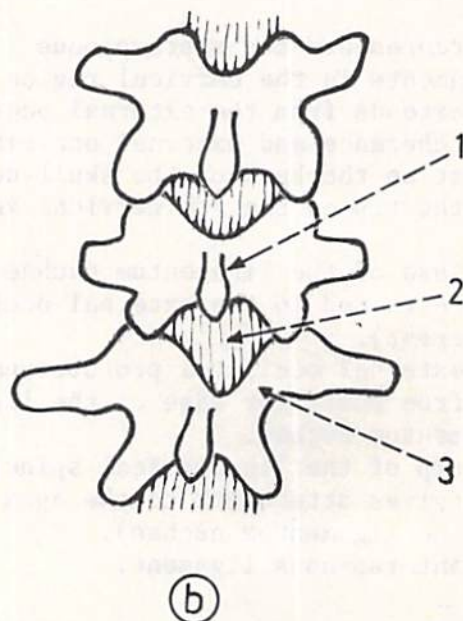
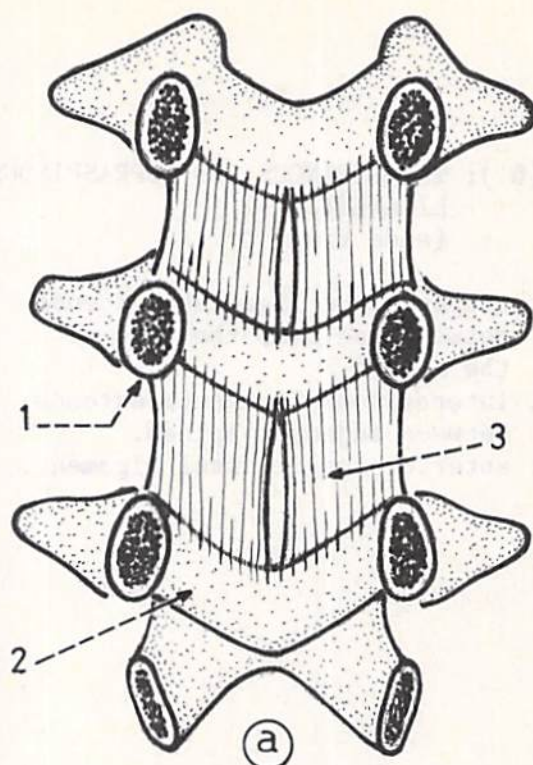
These are series of yellow elastic ligaments which extend between the laminae of adjacent vertebrae (flavus = yellow).

- (a) Ligamenta flava seen from inside the vertebral canal (the vertebral bodies are removed).

1. pedicle (cut).
2. lamina.
3. ligamentum flavum (between 2 laminae).

- (b) Ligamenta flava seen from outside (posterior aspect).

1. spine.
2. ligamentum flavum.
3. lamina.



MOVEMENTS OF THE VERTEBRAL COLUMN

The vertebral column has a wide range of movement; the movements permitted are: flexion, extension, bending to one side, rotation and circumduction.

Fig.(64): FLEXION MOVEMENT

In this movement the anterior parts of the intervertebral discs are compressed, while their posterior parts are stretched.

1. anterior part of the disc (compressed).
2. posterior part of the disc (stretched).

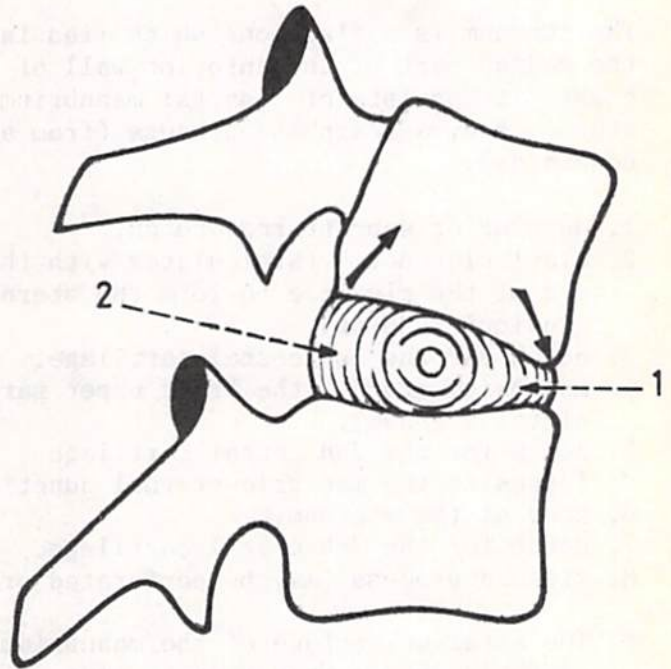
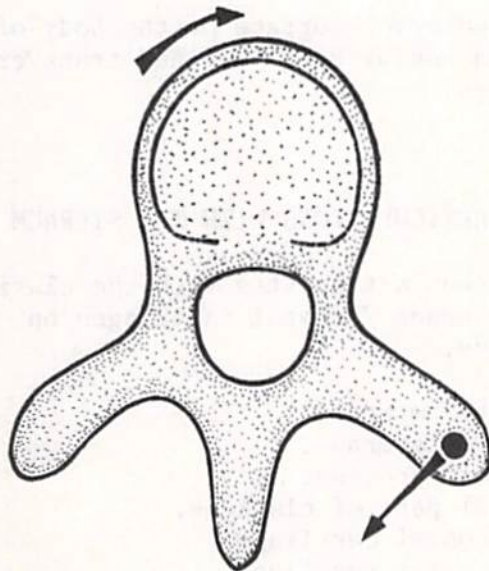


Fig.(65): ROTATION MOVEMENT

This movement is produced by twisting of the vertebrae on the intervertebral discs and is resisted mainly by the fibres of the annulus fibrosus.



STERNUM

Fig.(66): PARTS OF THE STERNUM
(anterior surface)

The sternum is a flat bone which lies in the median part of the anterior wall of the chest. It consists of 3 parts: manubrium sterni, body and xiphoid process (from above downwards).

1. jugular or suprasternal notch.
2. clavicular notch (articulates with the medial end of the clavicle to form the sternoclavicular joint).
3. notch for the 1st costal cartilage.
4. manubrium sterni (the broad upper part of the sternum).
5. notch for the 2nd costal cartilage (opposite the manubrio-sternal junction).
6. body of the sternum.
7. notch for the 7th costal cartilage.
8. xiphoid process (may be perforated or bifid).

* The anterior surface of the manubrium is slightly convex from side to side, while its posterior surface is slightly concave. Its lower border joins the body of the sternum at the sternal angle.

* The anterior surface of the body of the sternum is marked by 3 ill-defined transverse ridges.

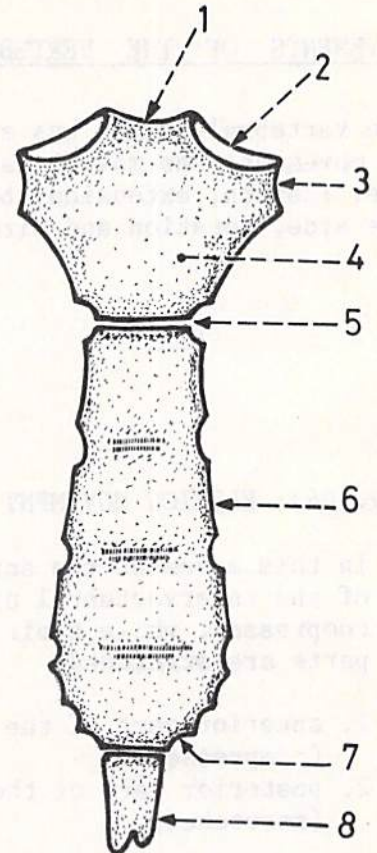


Fig.(67): ARTICULATIONS WITH THE STERNUM

The sternum articulates with the clavicle and the upper 7 costal cartilages on each side.

1. manubrium sterni.
2. body of sternum.
3. xiphoid process.
4. medial part of clavicle.
5. 1st costal cartilage.
6. 2nd costal cartilage.
7. 7th costal cartilage.

* Note that the 2nd costal cartilage lies at the manubrio-sternal junction, while the 7th costal cartilage lies at the junction between the body of sternum and xiphoid process.

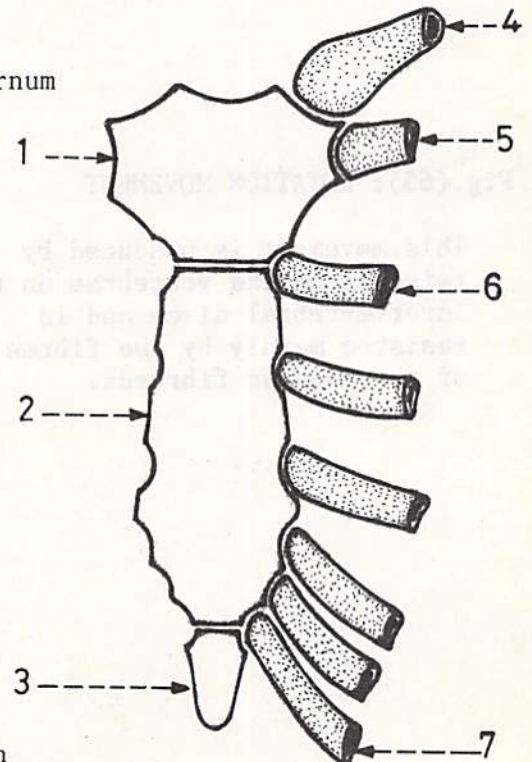


Fig.(68): LATERAL BORDER OF THE STERNUM

The lateral border of the sternum shows notches for the upper 7 costal cartilages (the clavicular notch is on the superior border of the manubrium).

1. clavicular notch.
2. notch for 1st costal cartilage (just below the clavicular notch).
3. notch for 2nd costal cartilage (at the manubrio-sternal junction).
4. notch for 7th costal cartilage (at the lower end of the body of sternum).
5. xiphoid process.
6. sternal angle (at the junction between the manubrium and body of sternum, on the anterior surface).

* Note that the anterior surface of the sternum is slightly convex, while the posterior surface is slightly concave.

* The sternal angle is a surface landmark which can be felt under the skin, and is taken as a guide to the 2nd costal cartilage.

* The upper 4 costal notches are widely separated from each other, while the lower 3 notches are close to each other.

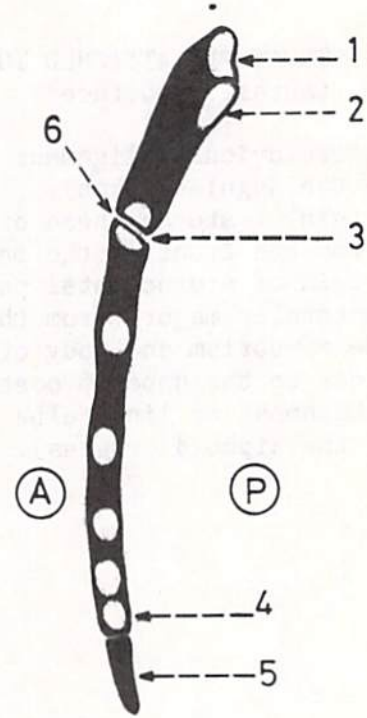


Fig.(69): VERTEBRAL LEVELS OF THE STERNUM

- * The manubrium sterni lies opposite the 3rd and 4th thoracic vertebrae.
- * The sternal angle lies opposite the disc between the 4th and 5th thoracic vertebrae.
- * The body of the sternum lies opposite the thoracic vertebrae from 5th to 9th.

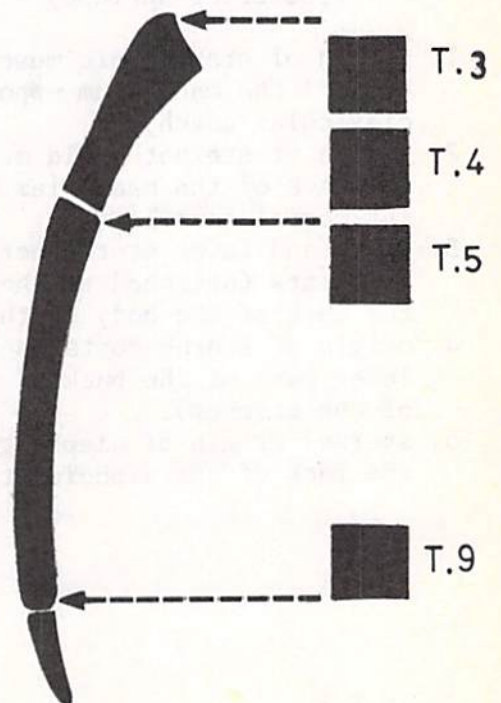


Fig.(70):STRUCTURES ATTACHED TO THE STERNUM
(anterior surface)

1. interclavicular ligament (attached to the jugular notch).
2. origin of sternal head of sternomastoid (from the front of the manubrium sterni).
3. origin of sternocostal part of pectoralis major (from the front of the manubrium and body of sternum close to the upper 6 costal cartilages).
4. attachment of linea alba (to the tip of the xiphoid process).

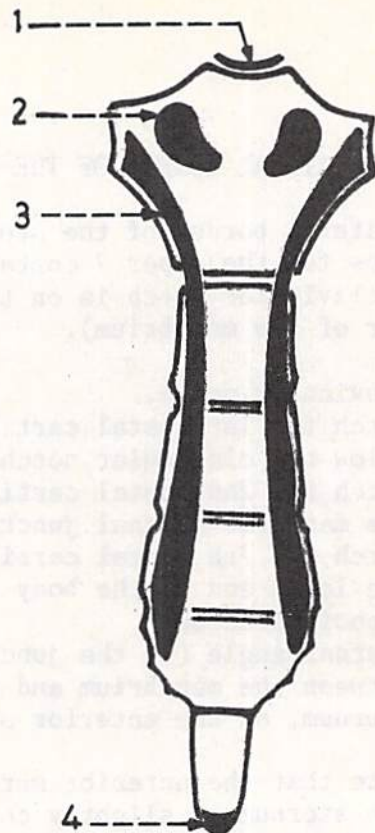


Fig.(71): STRUCTURES ATTACHED TO THE STERNUM
(posterior surface)

1. origin of sternohyoid muscle (from the back of the manubrium opposite the clavicular notch).
2. origin of sternothyroid muscle (from the back of the manubrium opposite the 1st costal cartilage).
3. upper and lower sterno-pericardial ligaments (attached to the midline of the back of the body of the sternum).
4. origin of sterno-costalis (from the lower part of the back of the body of the sternum).
5. sternal origin of diaphragm (from the back of the xiphoid process).

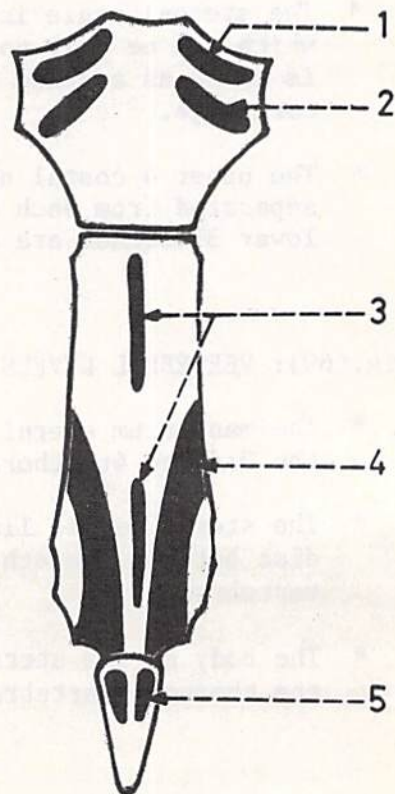


Fig.(72): RELATIONS OF THE POSTERIOR SURFACE OF THE STERNUM

The back of the manubrium is related to the arch of the aorta and its branches, while the back of the body of the sternum is related to the 2 lungs with their covering pleura as well as to the pericardium.

1. branches of the arch of the aorta (related to the upper 1/2 of the manubrium).
2. arch of the aorta (related to the lower 1/2 of the manubrium).
3. anterior border of left lung and pleura.
4. cardiac notch of left pleura.
5. anterior surface of pericardium (in direct contact with the sternum).
6. anterior border of right lung and pleura.

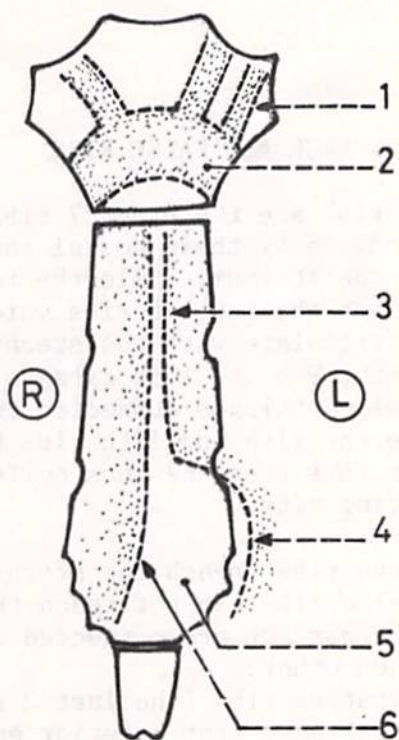
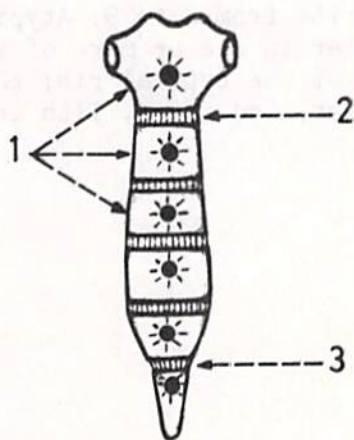


Fig.(73): OSSIFICATION OF THE STERNUM

The cartilagenous model of the sternum ossifies from 6 ossification centres; each centre forms a segment of the sternum called sternebra. The manubrium is the upper sternebra, the xiphoid process is the lower sternebra while the body represents the middle 4 sternebrae. The sternebrae of the body fuse together by the age of 25 years, while that of the xiphoid process fuses about middle age. The manubrium sterni remains separate, but may fuse with the body of the sternum in old age.

1. sternebrae.
2. cartilage at the manubrio-sternal junction.
3. cartilage between the xiphoid and body of sternum.



* The junctions between the 4 sternebrae of the body are marked on the anterior surface of the adult sternum by transverse ridges.

RIBS

Fig.(74): TRUE AND FALSE RIBS

True ribs are the upper 7 ribs which articulate by their costal cartilages with the sternum, while the false ribs are the lower 5 ribs which do not articulate with the sternum. The 8th, 9th and 10th ribs have their costal cartilages connected together, while the 11th and 12th ribs have their tips free and thus called floating ribs.

1. true ribs (reach the sternum).
2. false ribs (do not reach the sternum but are connected with each other).
3. floating ribs (the last 2 ribs which have free anterior ends).

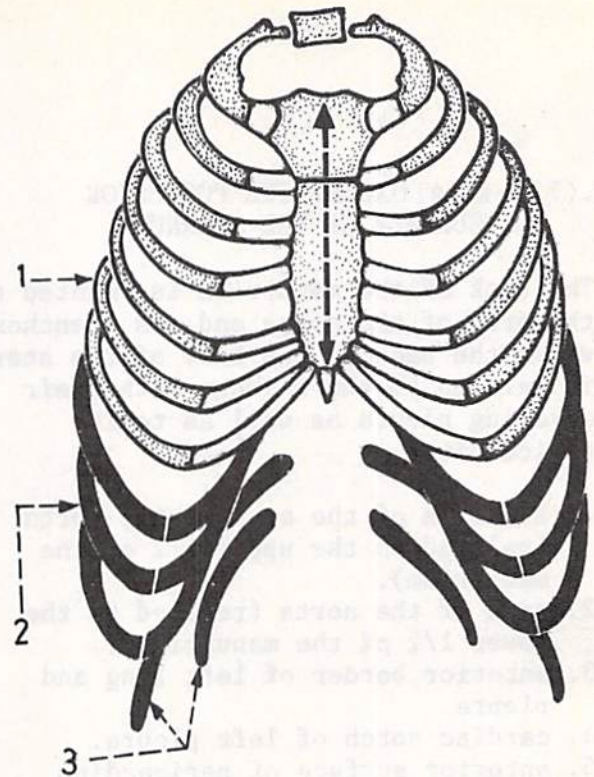
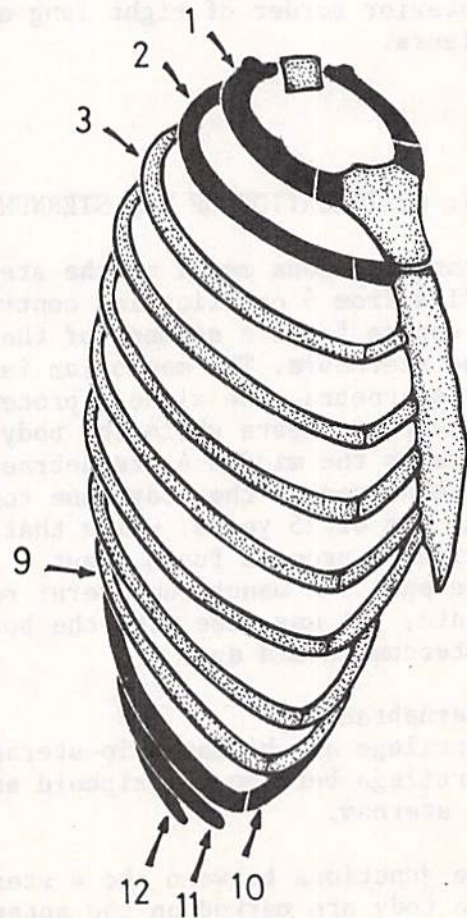


Fig.(75): TYPICAL AND ATYPICAL RIBS

Typical ribs are ribs which have all the basic features of a rib; these are the ribs from 3 to 9. Atypical ribs differ in one or more of the features of the typical rib; these are the 1st, 2nd, 10th, 11th and 12th.



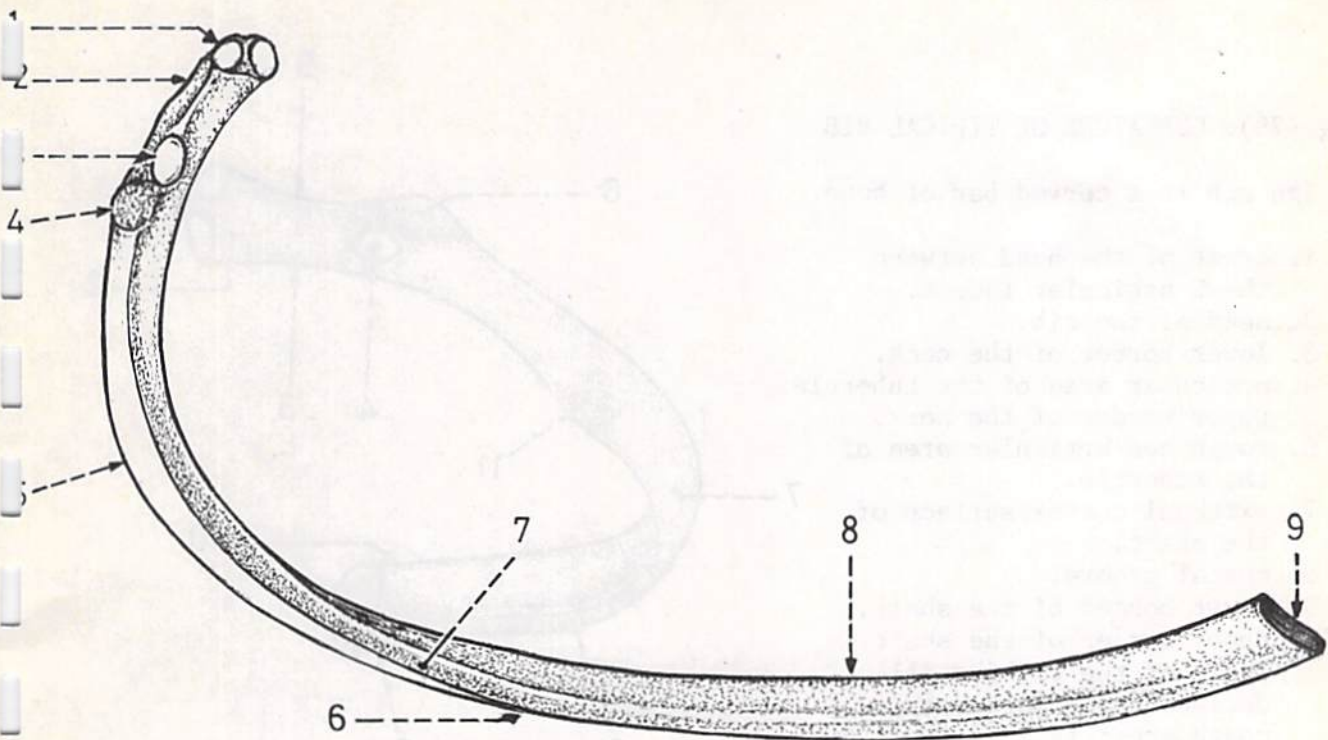


Fig.(76): FEATURES OF TYPICAL RIB (seen from below)

A typical rib consists of 2 ends and a shaft. The posterior end includes the head which bears 2 facets, the neck and the tubercle which has an articular part and a non-articular part. The shaft is curved and twisted and has a costal groove near its lower border. The anterior end fuses with the costal cartilage.

- | | |
|--------------------------------------|---|
| 1. head of the rib (bears 2 facets). | 5. angle of the rib (5 cm from the tubercle). |
| 2. neck of the rib. | 6. inferior border of the shaft. |
| 3. articular facet on the tubercle. | 7. costal groove. |
| 4. rough area of the tubercle. | 8. superior border of the shaft. |
| | 9. anterior end of the rib. |

Fig.(77): CROSS SECTION IN THE SHAFT OF THE RIB

1. upper border (rounded).
2. internal surface (concave).
3. costal groove (near the lower border).
4. lower border (sharp).
5. external surface (convex).

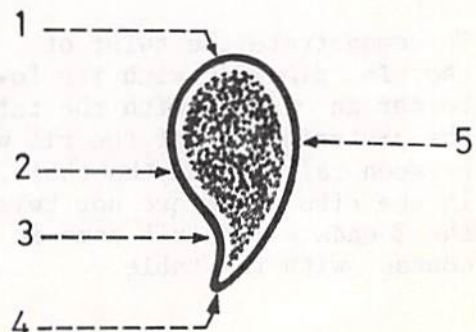


Fig.(78): CURVATURE OF TYPICAL RIB

The rib is a curved bar of bone.

1. crest of the head between the 2 articular facets.
2. head of the rib.
3. lower border of the neck.
4. articular area of the tubercle.
5. upper border of the neck.
6. rough non-articular area of the tubercle.
7. external convex surface of the shaft.
8. costal groove.
9. lower border of the shaft.
10. upper border of the shaft.
11. angle of the rib (an ill-defined angle marked by a rough area; it lies about 5 cm from the tubercle).

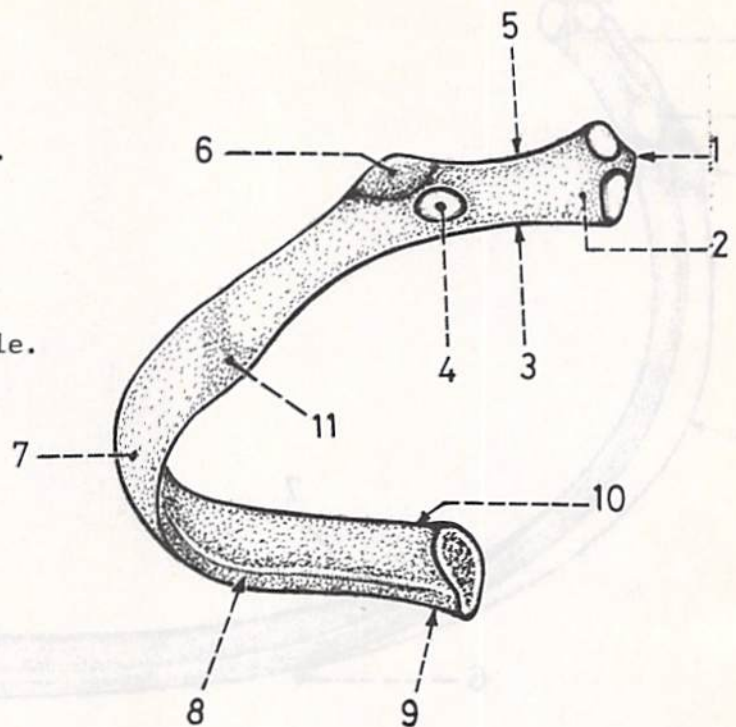
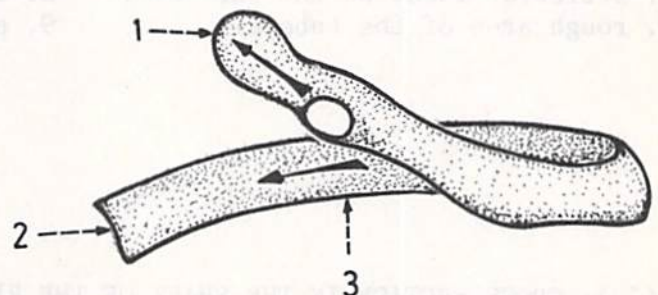


Fig.(79): TWIST OF TYPICAL RIB

The shaft of the typical rib is twisted in its long axis.

1. head of the rib (raised).
2. anterior end.
3. inferior border of the shaft.

* To demonstrate the twist of the rib, place it with its lower border in contact with the table; the posterior end of the rib will be seen raised from the table. In the ribs which are not twisted, the 2 ends of the rib come in contact with the table.



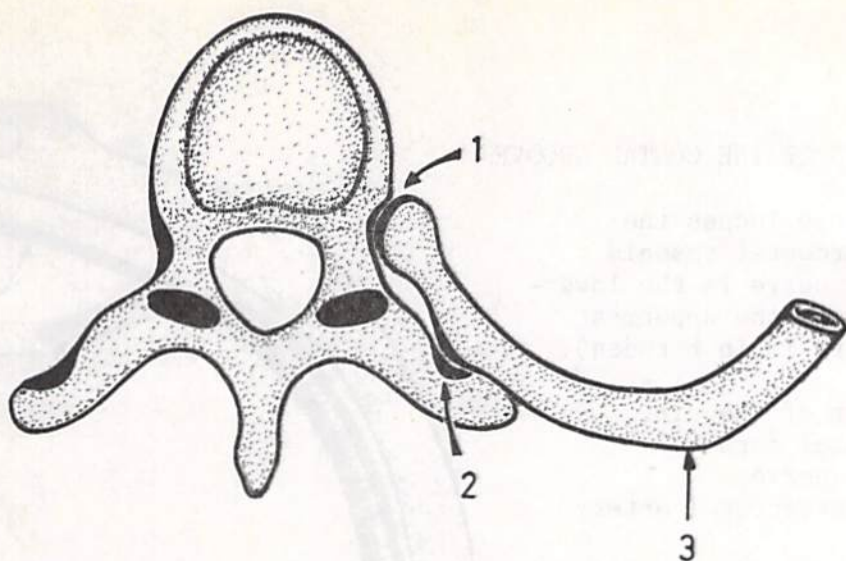


Fig.(80): ARTICULATIONS BETWEEN THE POSTERIOR END OF THE RIB AND THE VERTEBRA

The head of the typical rib articulates with the sides of 2 consecutive vertebrae (one of the same number as the rib and one above), while the tubercle of the rib articulates with the transverse process of the vertebra of the same number as the rib.

1. costo-vertebral joint (between the head of the rib and the side of the vertebra).
2. costo-transverse joint (between the tubercle of the rib and the transverse process of the vertebra).
3. angle of the rib.

Fig.(81): COSTO-VERTEBRAL JOINT

The 2 articular facets on the head of the rib articulate with the demi-facets on the sides of the bodies of 2 consecutive vertebrae, while the crest of the head lies opposite the disc between the 2 vertebrae.

1. upper facet on the head of the rib.
2. lower demifacet on the side of the body of the vertebra.
3. crest of the head of the rib (opposite the intervertebral disc).

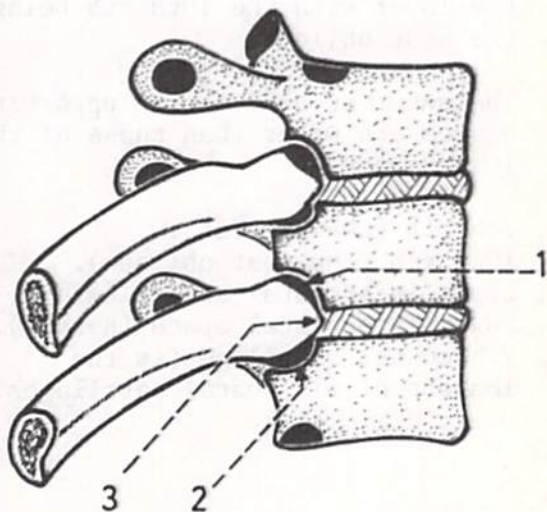


Fig.(82): CONTENTS OF THE COSTAL GROOVE

The costal groove lodges the posterior intercostal vessels and nerve (the nerve is the lowermost, the vein is the uppermost while the artery is in between).

1. upper border of the rib.
2. intervertebral foramen.
3. intercostal nerve.
4. posterior intercostal artery and vein.
5. costal groove.

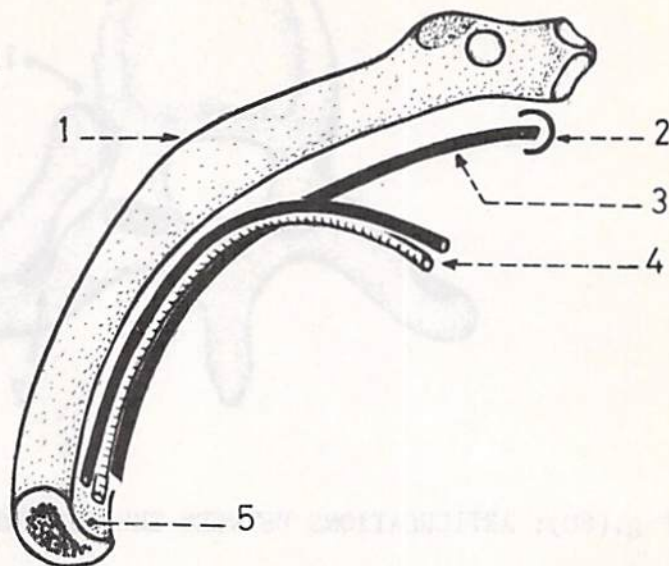


Fig.(83): LENGTH AND DIRECTION OF THE RIBS

- * The ribs increase in length from the 1st to the 7th which is the longest, then they gradually diminish.
- * The upper ribs are less oblique than the lower with the 10th rib being the most oblique.
- * The anterior ends of the upper intercostal spaces are wider than those of the lower spaces.

1. 7th rib (the longest).
2. 10th rib (the most oblique).
3. upper intercostal spaces (wide).
4. lower intercostal space (narrow).
5. 7th costal cartilage (is the longest of all costal cartilages).

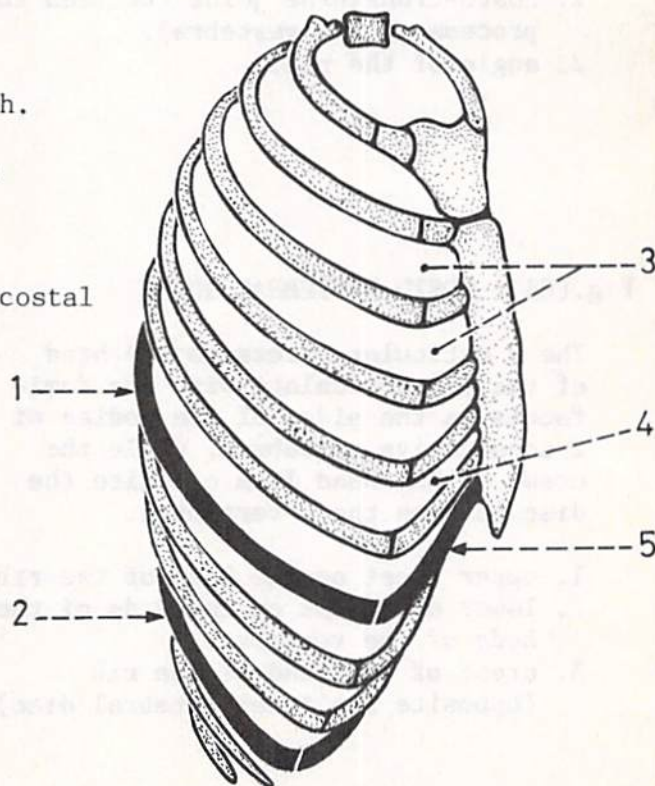


Fig.(84): FEATURES OF THE 1st RIB
(upper surface)

The 1st rib is the shortest and most curved of all ribs. It is broad and flat and its anterior end is much expanded and thickened than that of any of the other ribs.

1. neck (rounded rather than flat).
2. head (small and bears only one facet which articulates with a whole facet on the side of the body of the 1st thoracic vertebra).
3. scalene tubercle (projects on the inner border of the shaft).
4. inner border of the shaft.
5. anterior end (much expanded).
6. outer border of the shaft.
7. groove for subclavian vein (in front of the scalene tubercle).
8. groove for subclavian artery (behind the scalene tubercle).
9. tubercle (coincides with the angle of the rib).

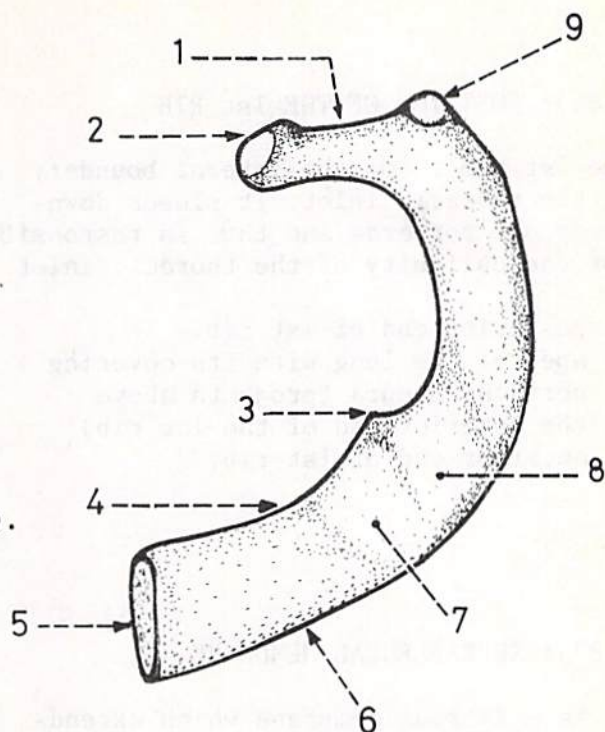


Fig.(85): STRUCTURES ATTACHED TO THE UPPER SURFACE OF 1st RIB

1. groove for subclavian artery.
2. insertion of scalenus anterior (into the scalene tubercle).
3. attachment of the costo-clavicular ligament.
4. origin of subclavius muscle.
5. groove for subclavian vein.
6. origin of 1st digitation of serratus anterior (from the outer border of the 1st rib opposite the groove for subclavian artery).
7. insertion of scalenus medius (between the tubercle of the rib and the groove for subclavian artery).

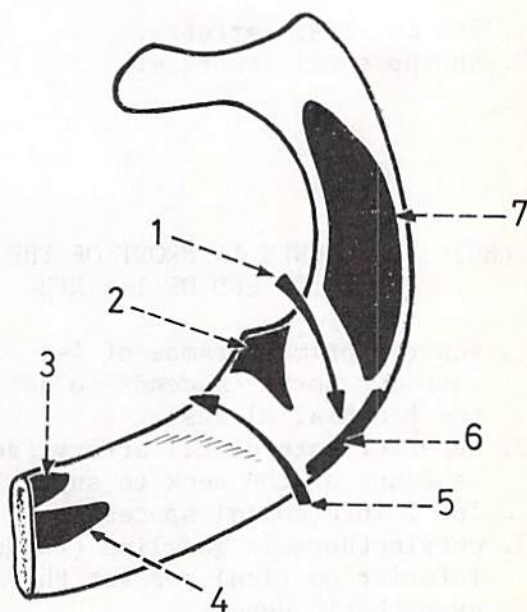


Fig.(86): POSITION OF THE 1st RIB

The 1st rib forms the lateral boundary of the thoracic inlet. It slopes downwards and forwards and thus is responsible for the obliquity of the thoracic inlet.

1. posterior end of 1st rib.
2. apex of the lung with its covering cervical pleura (projects above the anterior end of the 1st rib).
3. anterior end of 1st rib.

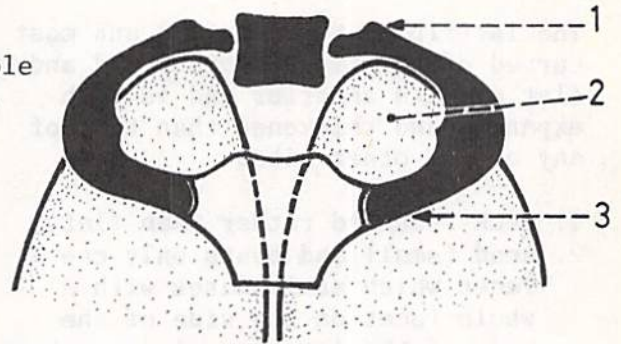


Fig.(87): SUPRAPLEURAL MEMBRANE

It is a fibrous membrane which extends from the transverse process of the 7th cervical vertebra to the inner border of the 1st rib. It overlies the cervical pleura which covers the apex of the lung.

1. 7th cervical vertebra.
2. suprapleural membrane.

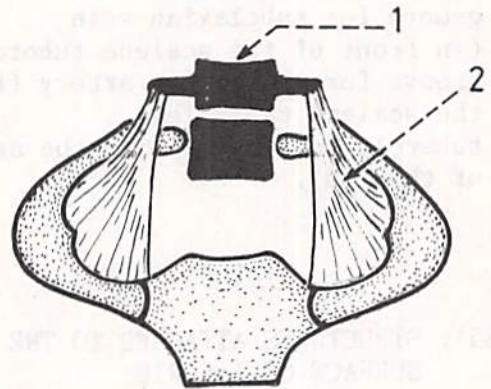
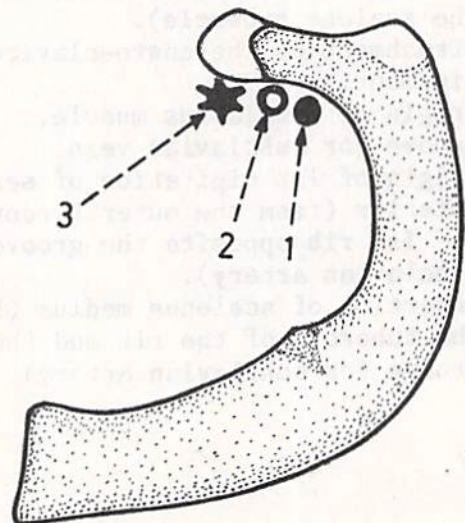


Fig.(88): STRUCTURES IN FRONT OF THE POSTERIOR END OF 1st RIB

1. ventral primary ramus of 1st thoracic nerve (ascends to join the brachial plexus).
2. superior intercostal artery (descends in front of the neck to supply the 1st 2 intercostal spaces).
3. cervicothoracic ganglion (fused inferior cervical and 1st thoracic sympathetic ganglia).



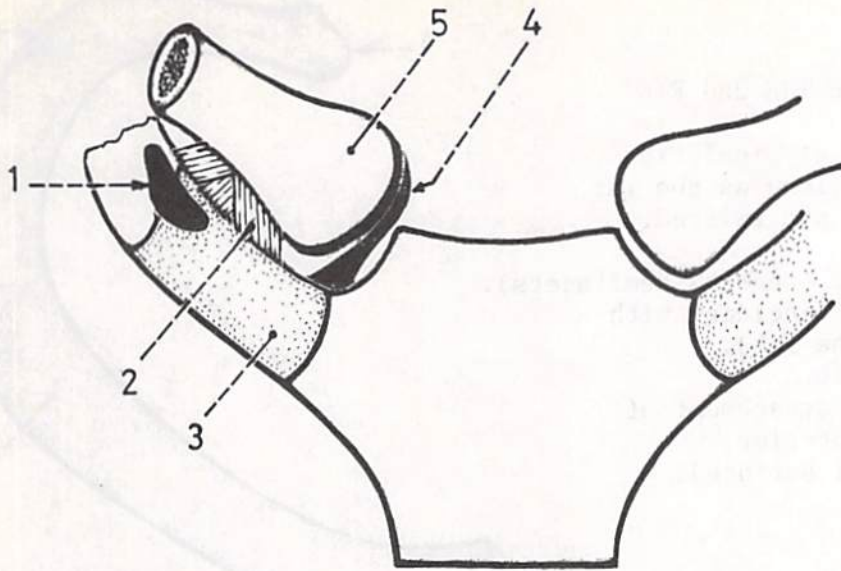


Fig.(89): STRUCTURES ATTACHED TO THE 1st COSTAL CARTILAGE

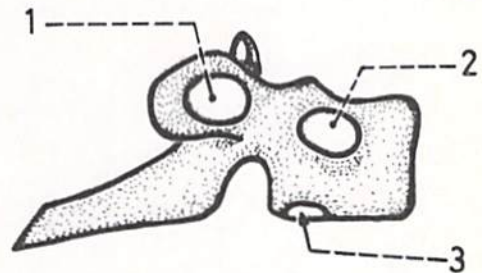
The 1st costal cartilage is attached to the clavicle by the costoclavicular ligament, the articular disc of the sternoclavicular joint and the subclavius muscle.

1. origin of subclavius muscle (from the upper surface of the rib at the costochondral junction).
2. costoclavicular ligament (lies deep to the origin of the subclavius).
3. 1st costal cartilage.
4. articular disc of the sternoclavicular joint.
5. medial end of the clavicle.

Fig.(90): FACETS FOR THE 1st RIB ON THE 1st THORACIC VERTEBRA

The head of the 1st rib articulates by a complete facet on the side of the body of the 1st thoracic vertebra near its upper border. The tubercle of the 1st rib articulates with the transverse process of the same vertebra.

1. facet on the transverse process for the tubercle of the 1st rib.
2. complete facet on the side of the body for the head of the 1st rib.
3. a small demifacet at the lower border of the body for the upper facet on the head of the 2nd rib.



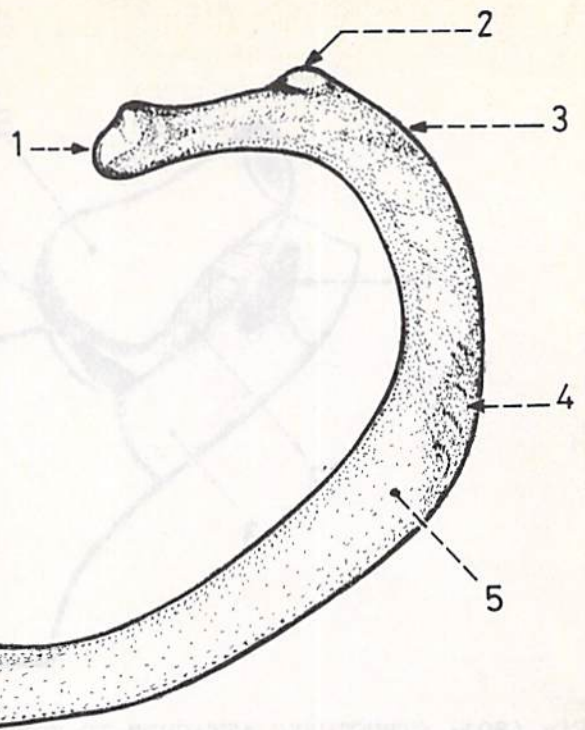


Fig.(91): FEATURES OF THE 2nd RIB

The 2nd rib is an atypical rib which is twice as long as the 1st rib. Its shaft is not twisted.

1. head of the rib (bears 2 demifacets).
2. tubercle (not coinciding with the angle of the rib).
3. angle of the rib.
4. rough area for attachment of the serratus anterior.
5. shaft (external surface).

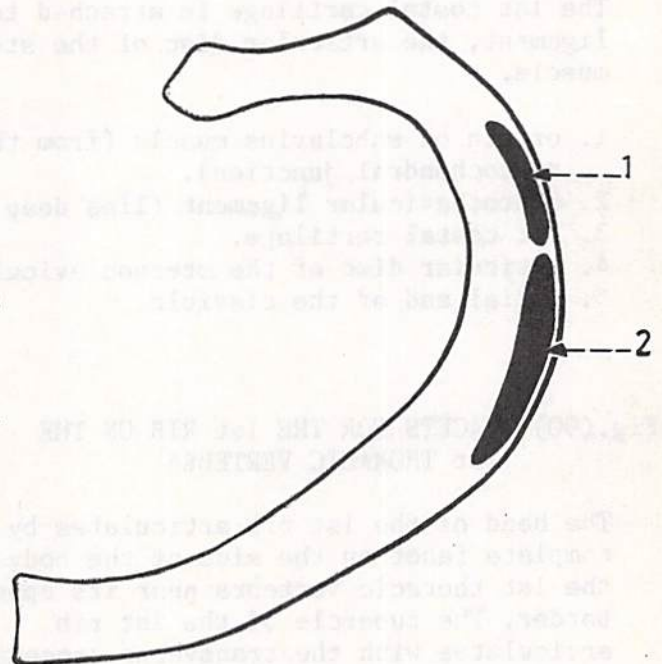


Fig.(92): MUSCLES ATTACHED TO THE 2nd RIB

1. insertion of scalenus posterior.
2. origin of serratus anterior (from a rough impression at the middle of the external surface of the rib).

Fig.(93): THE SHAFT OF THE 2nd RIB IS NOT TWISTED

To demonstrate this feature, put the rib with its lower border in contact with the table; its 2 ends will touch the surface of the table.



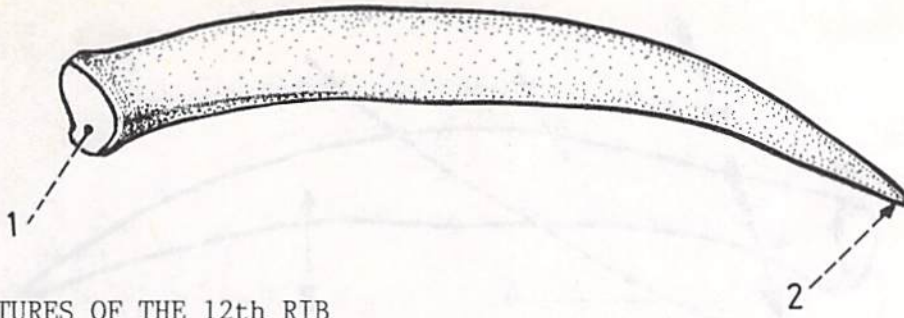


Fig.(94): FEATURES OF THE 12th RIB

The 12th rib has neither a neck nor a tubercle, its head bears a single facet and its anterior end is pointed. (These features are the same for the 11th rib; the difference is that the 12th rib is shorter than the 11th rib.)

1. head of the rib (bears a single facet).
2. anterior end (pointed).

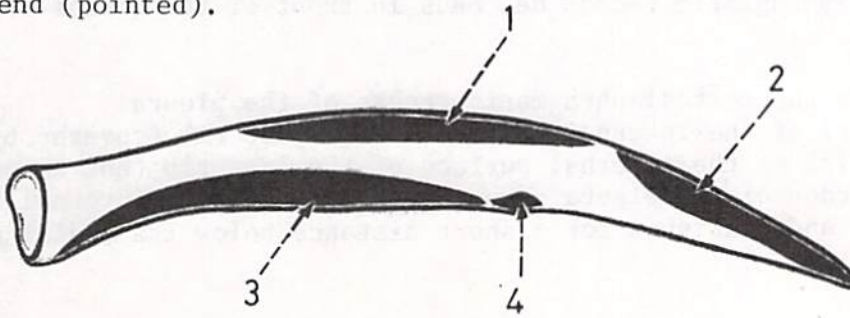


Fig.(95): STRUCTURES ATTACHED TO THE INTERNAL SURFACE OF THE 12th RIB

1. insertion of internal intercostal muscle (along the upper border).
2. origin of diaphragm.
3. insertion of quadratus lumborum muscle (close to the lower border).
4. attachment of the lateral arcuate ligament.



Fig.(96): STRUCTURES ATTACHED TO THE EXTERNAL SURFACE OF THE 12th RIB

1. origin of latissimus dorsi (close to the upper border).
2. origin of external oblique muscle of abdomen (along the lower border).
3. insertion of erector spinae muscle (along the lower border).

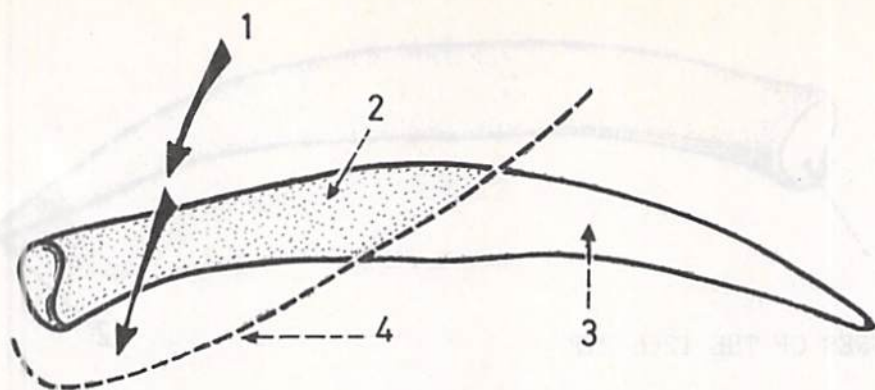


Fig.(97): RELATION OF THE LAST RIB TO THE COSTODIAPHRAGMATIC RECESS OF THE PLEURA

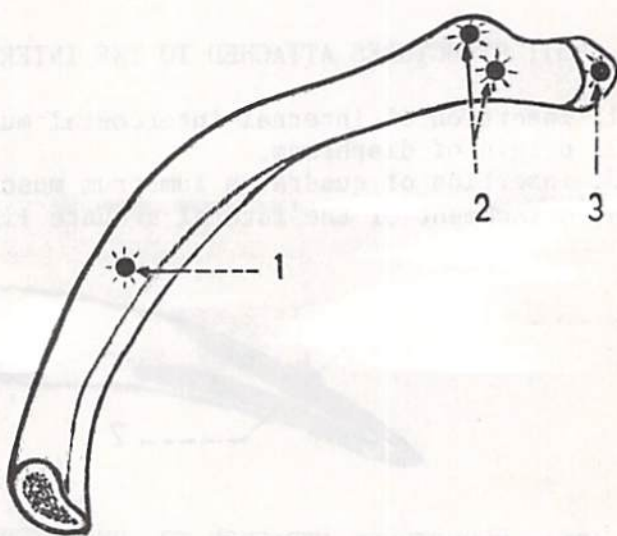
The costodiaphragmatic recess descends in front of the medial 1/2 of the 12th rib.

1. arrows in the costodiaphragmatic recess of the pleura.
2. medial 1/2 of the internal surface of the last rib (covered by the pleura).
3. lateral 1/2 of the internal surface of the last rib (not covered by pleura).
4. lower border of the pleura crossing in front of the internal surface of the last rib and continues for a short distance below its medial part.

Fig.(98): OSSIFICATION OF A TYPICAL RIB

A rib ossifies from 4 centres: one primary for the shaft and 3 secondary (for the head and tubercle). The 2ry centres form the posterior end of the rib which fuses with the shaft about 20 years.

1. primary centre for the shaft (appears by 8th week of intra-uterine life).
2. two secondary centres for the tubercle.
3. one secondary centre for the head.



JOINTS AND MOVEMENTS OF THORACIC CAGE

JOINTS OF THORACIC CAGE

These are: costovertebral, costotransverse and sternocostal joints, in addition to the joints of the sternum (manubriosternal and xiphisternal joints).

Fig.(99): COSTOVERTEBRAL JOINT

It is the joint between the head of the rib and sides of the bodies of 2 thoracic vertebrae. It is a synovial joint with its capsule supported from the front by the radiate ligament (marked by arrow). The radiate ligament radiates from the front of the head of the rib to the bodies of 2 adjoining vertebrae and the disc in between.

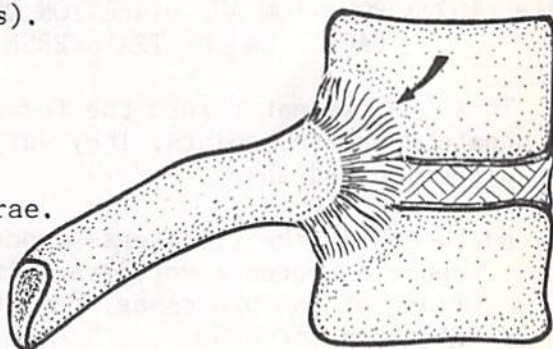


Fig.(100): COMPARTMENTS OF THE COSTOVERTEBRAL JOINT

In case of a typical rib with its head articulating with 2 adjoining vertebrae, the costovertebral joint is formed of 2 compartments (upper and lower) separated from each other by the intra-articular ligament. This ligament extends from the crest on the head of the rib to the intervertebral disc.

1. intra-articular ligament.
2. upper compartment of the joint.
3. head of the rib.
4. lower compartment of the joint.

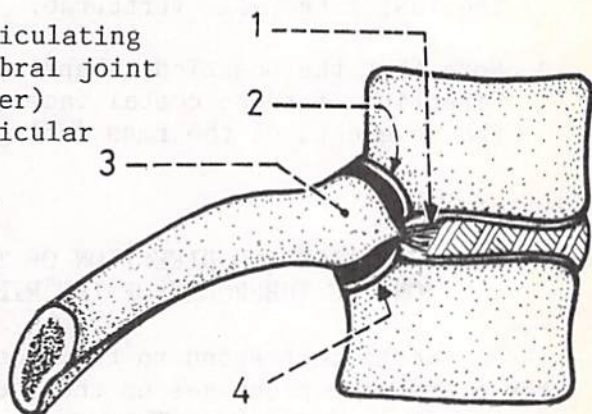


Fig.(101): COSTOTRANSVERSE JOINT AND ITS LIGAMENTS

This is a synovial joint between the tubercle of the rib and the transverse process of the vertebra. It is supported by 3 ligaments.

1. superior costotransverse ligament: from the upper border of the neck of the rib to the transverse process of the vertebra just above.
2. lateral costotransverse ligament: from the tubercle of the rib to the tip of the corresponding transverse process.
3. costotransverse ligament: from the back of the neck of the rib to the front of the transverse process just behind. (It is also called inferior costotransverse ligament.)

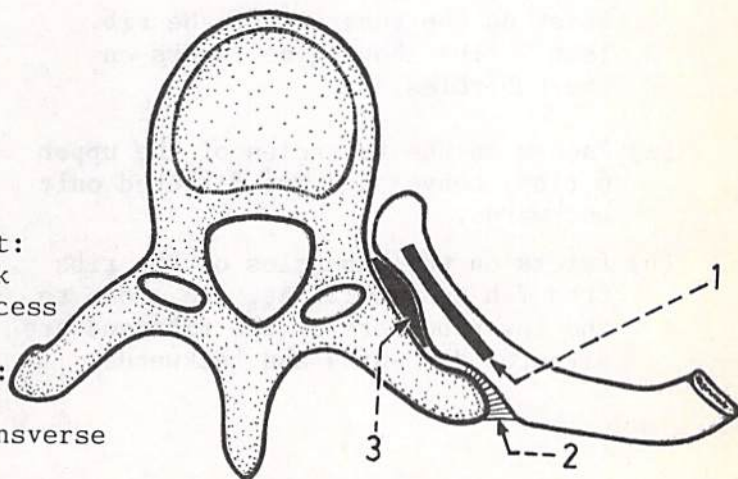


Fig.(102): POSITION AND DIRECTION OF THE COSTAL FACETS ON THE TRANSVERSE PROCESSES

These facets enter into the formation of the costotransverse joints. They vary in position, direction and shape.

- (a) Facets on the transverse processes of the upper 6 thoracic vertebrae: lie on the front of the processes, concave and are directed forwards.
- (b) Facets on the transverse processes of the thoracic vertebrae from 7th to 10th: lie close to the upper borders of the processes, flat and are directed mainly upwards.
- (c) No facets on the transverse processes of the last 2 thoracic vertebrae.

* Note that the position, shape and direction of these costal facets affect the movements of the ribs during respiration.

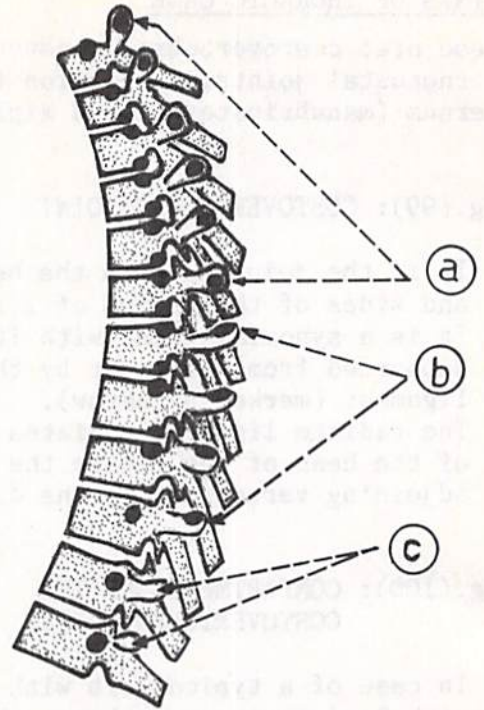


Fig.(103): POSITION AND DIRECTION OF THE FACETS ON THE TUBERCLES OF THE RIBS

These facets correspond to the facets on the transverse processes on the thoracic vertebrae in fig.(102). They form together the costotransverse joints.

1. facet on the tubercle of the rib.
 2. last 2 ribs showing no facets on the tubercles.
- (a) Facets on the tubercles of the upper 6 ribs: convex and are directed only backwards.
 - (b) facets on the tubercles of the ribs from 7th to 10th: flat, lie close to the lower borders of the ribs and are directed downwards and backwards.

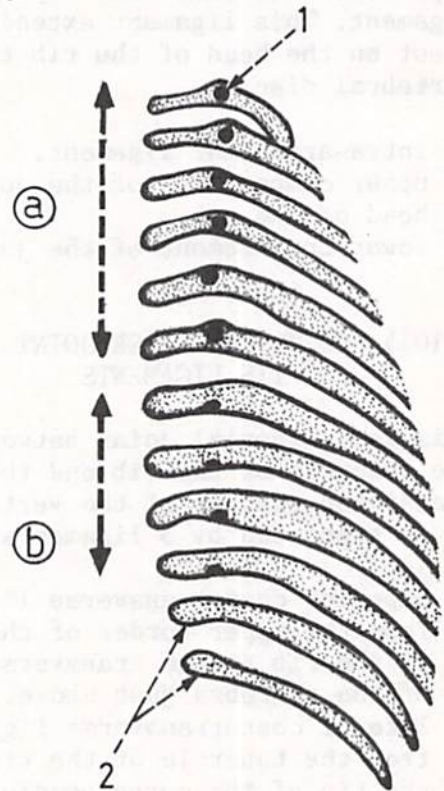


Fig.(104): SHAPE AND DIRECTION OF THE ARTICULAR SURFACES OF THE COSTOTRANSVERSE JOINTS

In the upper 6 joints the articular surfaces are reciprocally curved, and are directed forwards; the movement here is rotation.

The articular surfaces of the joints from the 7th to the 10th are flat and more horizontal in position; the movement here is gliding.

1. one of the upper costotransverse joints (reciprocally curved surfaces).
2. one of the lower costotransverse joints (flat surfaces and the direction is more horizontal).

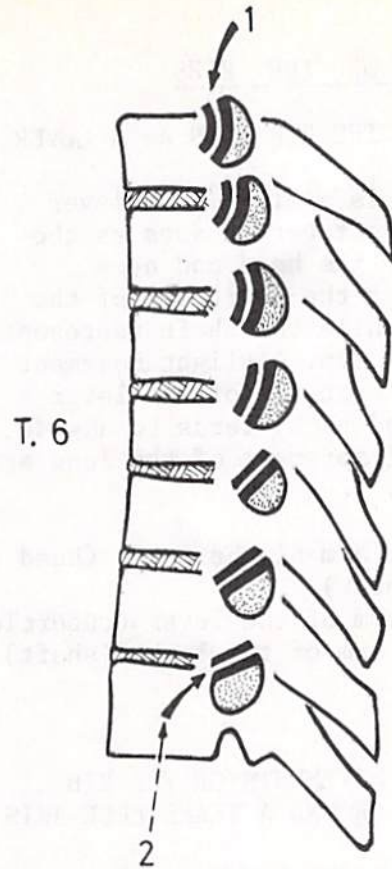
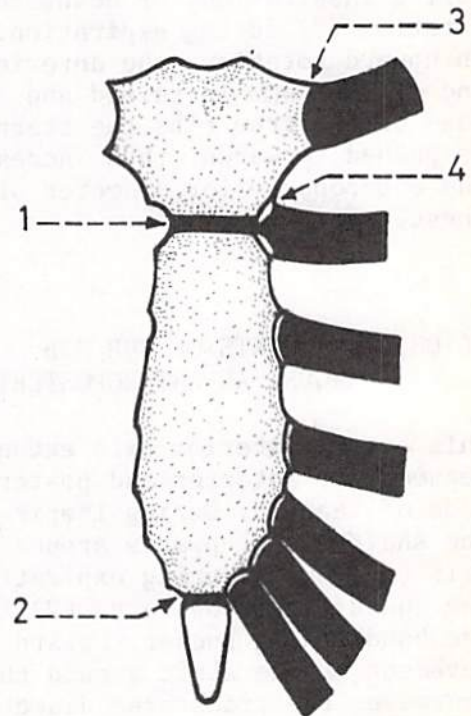


Fig.(105): STERNOCOSTAL JOINTS

These are the joints between the costal cartilages and the notches on the lateral margin of the sternum.

The parts of the sternum articulate together at 2 joints (manubriosternal and xiphisternal).

1. manubriosternal joint: symphysis (disc of fibrocartilage).
2. xiphisternal joint: symphysis (disc of fibrocartilage).
3. 1st sternocostal joint: synchondrosis (primary cartilagenous joint where the costal cartilage fuses directly with the manubrium sterni).
4. 2nd sternocostal joint: synovial.



* The sternocostal joints from the 2nd to the 7th are synovial, and allow movements of the anterior ends of the ribs during respiration.

MOVEMENTS OF THE RIBS

Fig.(106): THE RIB ACTS AS A LEVER

The rib is similar to a lever where its tubercle acts as the fulcrum, its head and neck represent the short arm of the lever, while the shaft represents the long arm. A slight movement of the short arm of the lever (head and neck) leads to a wide range of movement of the long arm (shaft).

1. short arm of the lever (head and neck).
2. fulcrum of the lever (tubercle).
3. long arm of the lever (shaft).

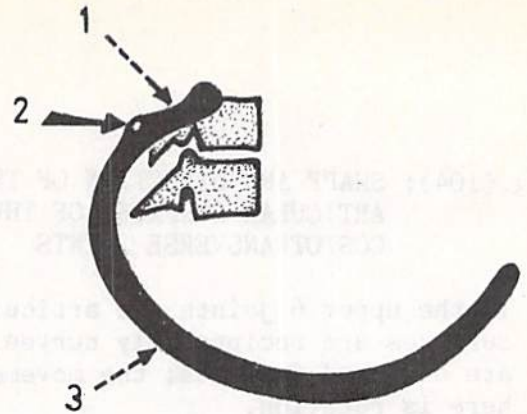


Fig.(107): MOVEMENTS OF THE RIB
AROUND A TRANSVERSE AXIS

This transverse axis passes through the costovertebral and costotransverse joints. The movement around this axis is either upward rotation (1) during inspiration, or downward rotation (2) during expiration. In upward rotation, the anterior end of the shaft is raised and in case of the true ribs the sternum is pushed forwards, thus increasing the anteroposterior diameter of the chest.

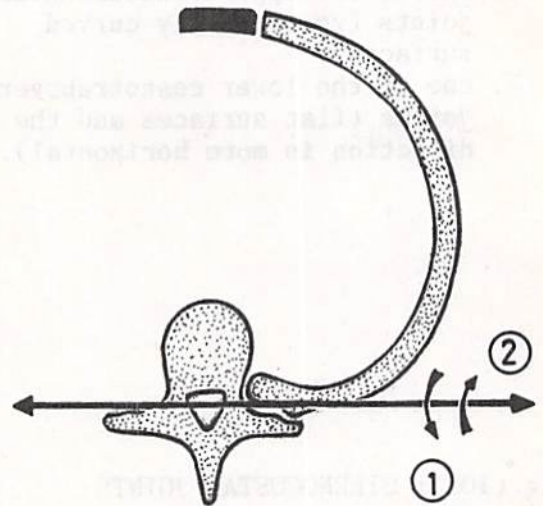
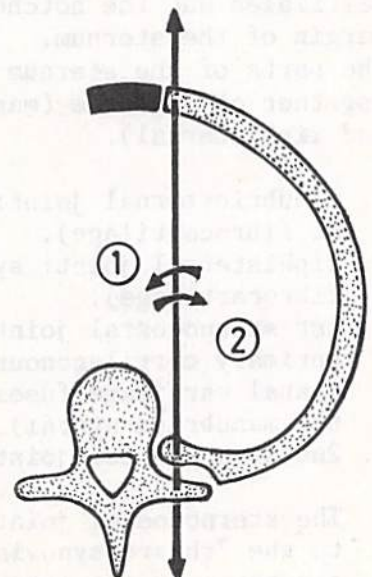


Fig.(108): MOVEMENTS OF THE RIB
AROUND AN ANTEROPOSTERIOR AXIS

This anteroposterior axis extends between the anterior and posterior ends of the rib. During inspiration the shaft moves upwards around this axis (1), while during expiration the shaft moves downwards (2) like the handle of a bucket. Upward movement of the shaft around this axis increases the transverse diameter of the chest (bucket-handle movement).



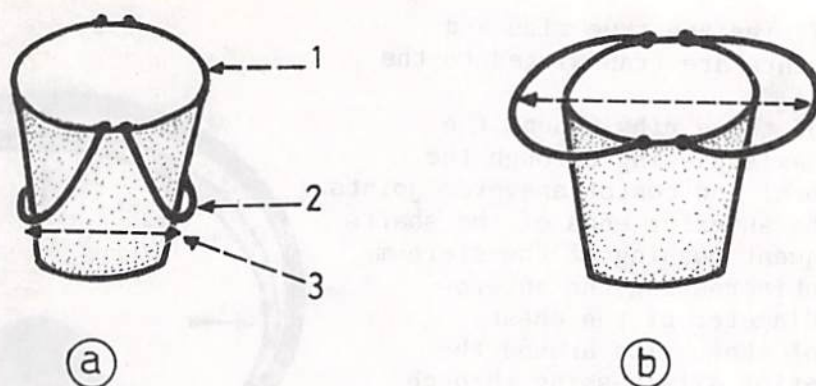


Fig.(109): BUCKET-HANDLE MOVEMENT

The movement of the rib upwards or downwards around the anteroposterior axis resembles the upward and downward movement of the handle of a bucket.

(a) The handles of the bucket in a downward position.

1. bucket
2. handle of the bucket.
3. transverse diameter between the 2 handles of the bucket.

(b) The handles of the bucket in an elevated position.

In this position the transverse diameter between the 2 handles is increased.

Fig.(110): ELEVATION OF A RIB

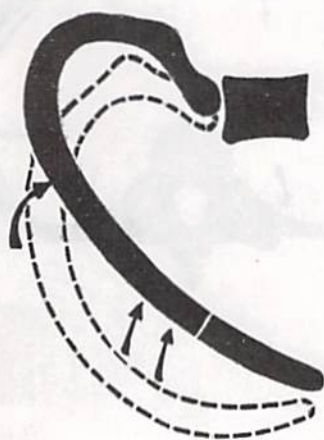


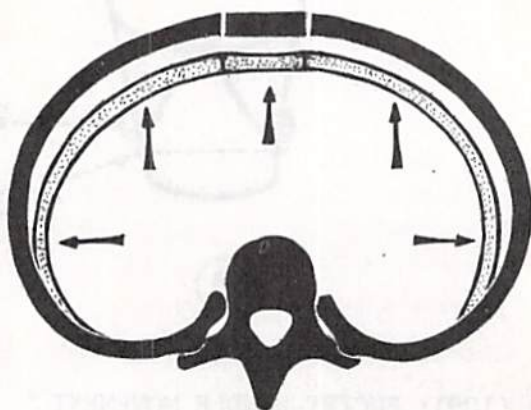
Fig.(111): BACKWARD MOVEMENT OF A RIB



Fig.(112): MOVEMENTS OF THE UPPER 7 RIBS

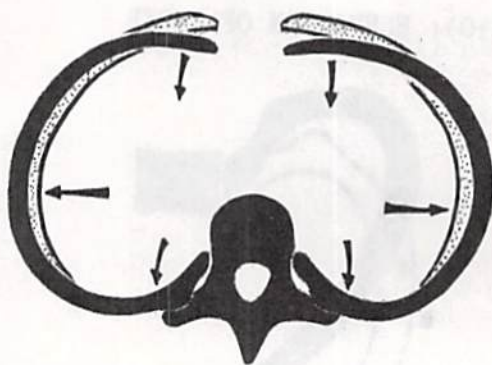
The upper 7 ribs are true ribs and their movements are transmitted to the sternum.

Movements of these ribs around the transverse axis passing through the costovertebral and costotransverse joints elevate the anterior ends of the shafts with consequent pushing of the sternum forwards and increasing the anteroposterior diameter of the chest. Movements of these ribs around the anteroposterior axis passing through the anterior and posterior ends of the ribs elevate the middle parts of the shafts, thus increasing the transverse diameter of the chest (bucket-handle movement).

Fig.(113): MOVEMENTS OF THE
8th TO 10th RIBS

These 3 ribs are false ribs and thus their movements are not transmitted to the sternum (the 11th and 12th ribs do not move). Elevation of these ribs is not accompanied by rotation at the neck because their costotransverse joints are flat and are placed more horizontally. Instead, the ribs move backwards gliding on the flat costotransverse joints, without increasing the anteroposterior diameter of the lower part of the chest.

However, movements of these ribs around the anteroposterior axis raise the middle parts of the shafts and increase the transverse diameter of the lower part of the chest cavity (bucket-handle movement).



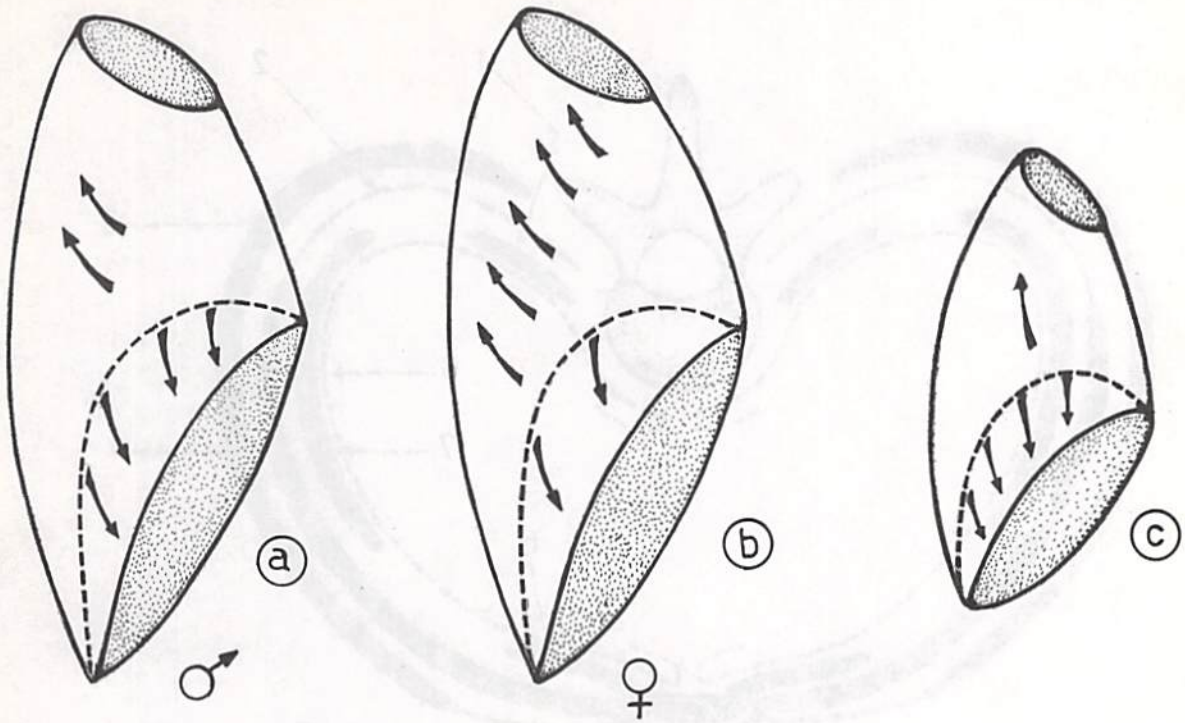


Fig.(114): QUIET INSPIRATION

During quiet inspiration, the diameters of the chest cavity increase by the action of the intercostal muscles as well as the diaphragm. Respiration is of 2 types: thoracic (mainly by intercostal muscles) and abdominal (mainly by diaphragm).

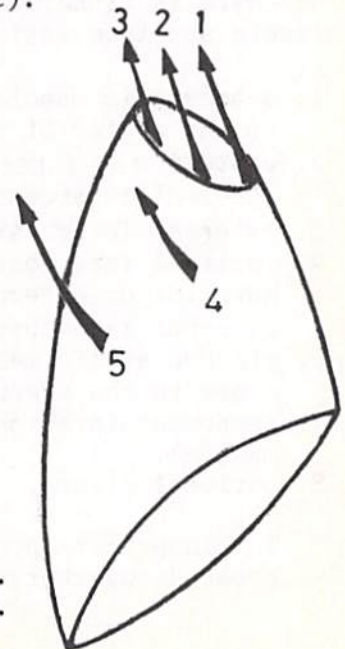
- (a) Respiration in the male: it is mainly abdominal.
- (b) Respiration in the female: it is mainly thoracic.
- (c) Respiration in babies and young children: it is abdominal because the ribs are nearly horizontal (with no bucket-handle movement).

Fig.(115): FORCED INSPIRATION

In respiratory distress, other muscles are brought into action to raise the ribs. These muscles are mainly attached at the thoracic inlet or to the sides and front of the chest wall.

1. sternomastoid (attached to the manubrium sterni).
2. scalenus anterior (attached to the 1st rib).
3. scalenus medius (attached to the 1st rib).
4. pectoralis minor (attached to the front of the chest).
5. serratus anterior (attached to the side of the chest).

* In forced inspiration the scapula must be fixed.



MUSCLES OF THORACIC WALL

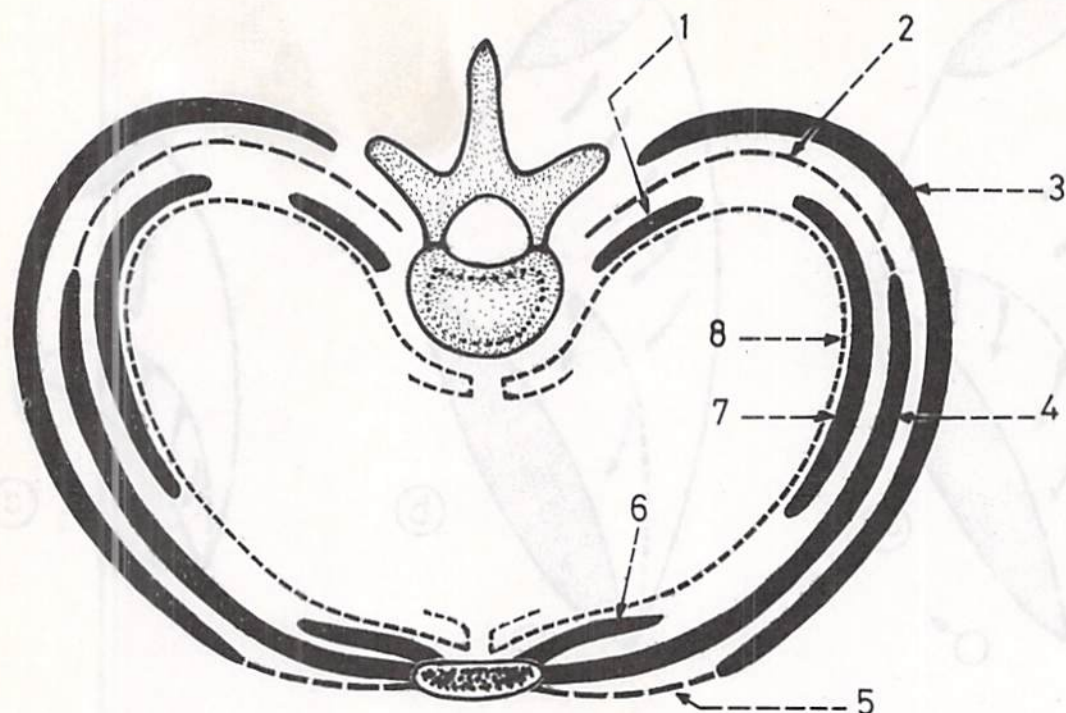


Fig.(116): ARRANGEMENT OF MUSCLES OF THE THORACIC WALL (T.S.)

The muscles of the thoracic wall are generally arranged into 3 layers as follows (from outside inwards): external intercostal (outermost), internal intercostal (in the middle) and innermost intercostal, sternocostalis and subcostalis (innermost). These muscles are covered from outside by skin and fascia and from inside by the parietal pleura.

1. subcostalis muscle (lies on the inner surface of the thoracic wall, medial to the angles of the ribs).
2. posterior or internal intercostal membrane (backward continuation of the internal intercostal muscle).
3. external intercostal muscle (outermost).
4. internal intercostal muscle (the middle layer).
5. anterior or external intercostal membrane (anterior continuation of the external intercostal muscle).
6. sternocostalis muscle (lies on the inner surface of the thoracic wall close to the sternum).
7. innermost intercostal muscle (to the inside of the internal intercostal muscle).
8. parietal pleura.

* The innermost intercostal, subcostalis and sternocostalis muscles may be grouped together under the name "transversus thoracis".

Fig.(117): EXTERNAL INTERCOSTAL MUSCLE

It is the outermost muscle in the intercostal space. It arises from the lower border of the rib above and is inserted into the upper border of the rib below.

1. tubercle of the rib (posterior extent of the muscle).
2. origin of the muscle from the rib above the space.
3. external intercostal muscle filling the intercostal space.
4. direction of muscle fibres (downwards and forwards).
5. costochondral junction (anterior extent of the muscle).
6. anterior or external intercostal membrane (anterior continuation of the muscle to the margin of the sternum).

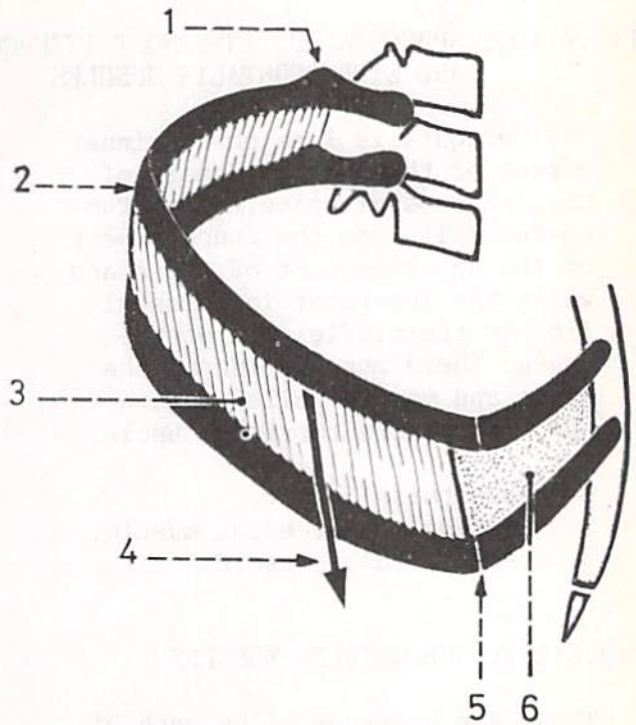
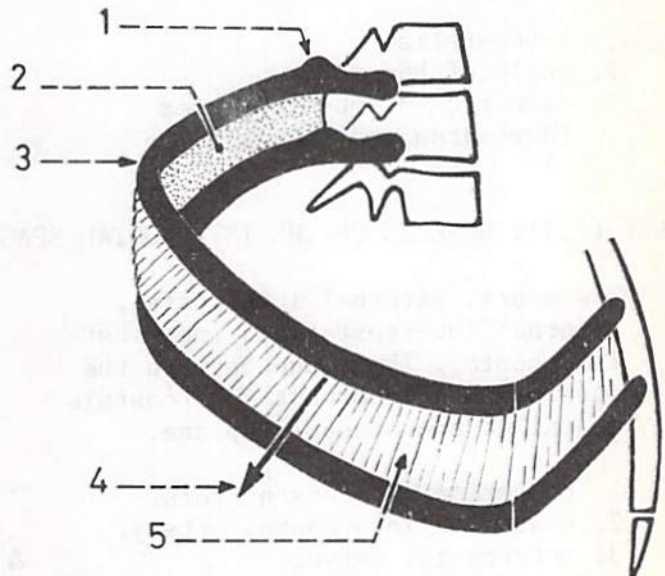


Fig.(118): INTERNAL INTERCOSTAL MUSCLE

It lies in the intercostal space deep to the external intercostal. It runs from the costal groove of the rib above to the upper border of the rib below. It extends from the sternum to the angle of the rib.

1. tubercle of the rib.
2. posterior or internal intercostal membrane (backward continuation of the muscle, medial to the angle of the rib).
3. origin of the muscle from the rib above the space.
4. direction of muscle fibres (downwards and backwards).
5. internal intercostal muscle.



* Note that the internal intercostal muscle ends posteriorly in a membrane, while the external intercostal muscle ends anteriorly in a membrane.

* Note also that the fibres of the external intercostal run at right angle to those of the internal intercostal.

Fig.(119): SUBCOSTALIS, INNERMOST INTERCOSTAL AND STERNOCOSTALIS MUSCLES

The subcostalis lies on the inner aspect of the posterior part of the intercostal space, the sternocostalis lies on the inner aspect of the anterior part of the space, while the innermost intercostal lies in the middle part of the space. The 3 muscles lie on one plane and may be called together the transversus thoracis muscle.

1. subcostalis muscle.
2. innermost intercostal muscle.
3. sternocostalis muscle.

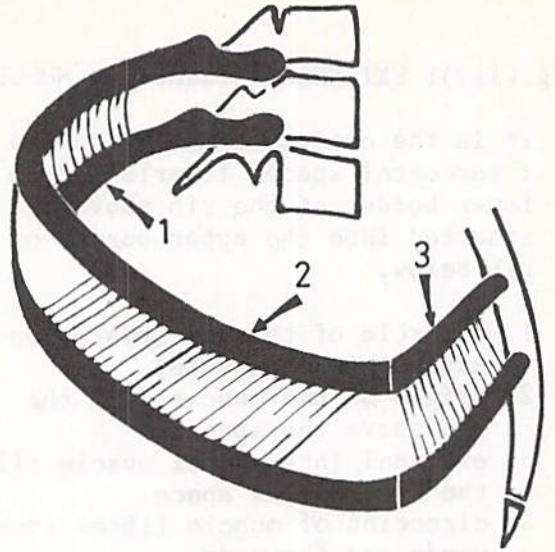


Fig.(120): SUBCOSTALES MUSCLES

These are numerous slips each of which is called subcostalis muscle. Each subcostalis arises from the inner surface of the rib near its angle and runs downwards and medially to be inserted into the 2nd or 3rd rib below.

1. subcostalis.
2. angle of the rib.
3. direction of muscle fibres (downwards and medially).

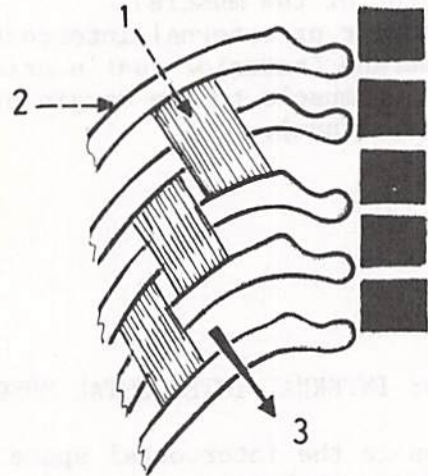


Fig.(121): MUSCLES OF THE INTERCOSTAL SPACE

These are: external intercostal, internal intercostal and innermost intercostal. The plane between the internal and innermost intercostals is called neurovascular plane.

1. posterior intercostal vein.
2. posterior intercostal artery.
3. intercostal nerve.
4. neurovascular plane (between the internal and innermost intercostal muscles).
5. innermost intercostal muscle.
6. internal intercostal muscle.
7. external intercostal muscle.

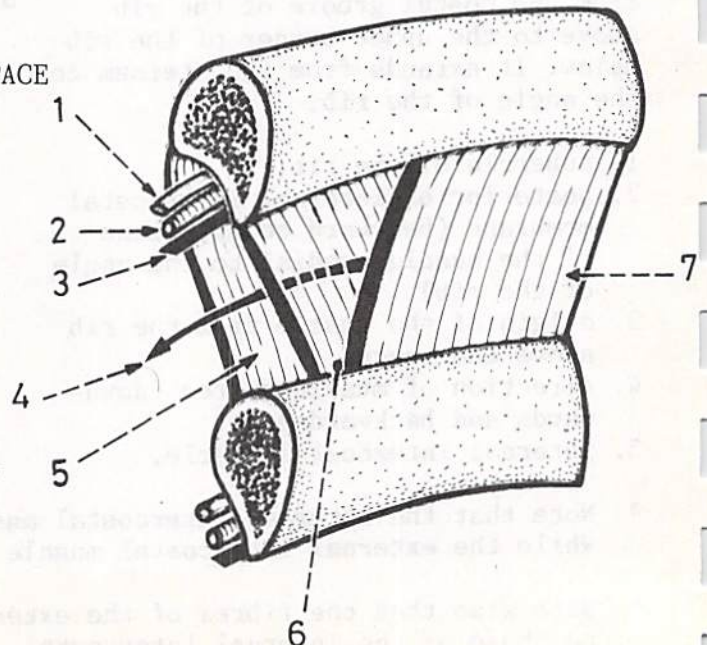
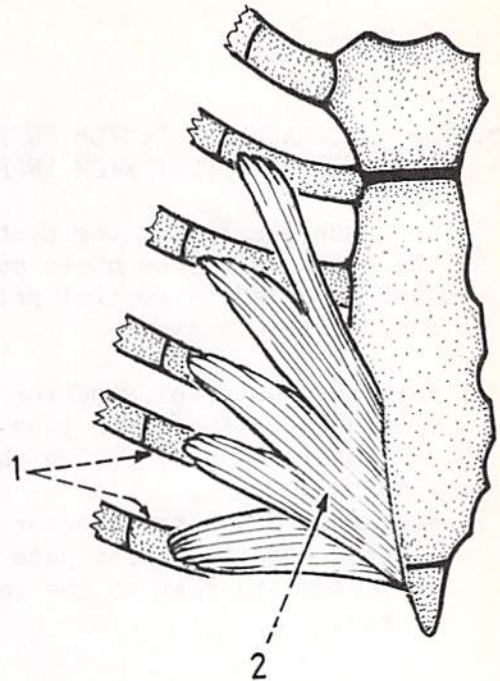


Fig.(122): STERNOCOSTALIS MUSCLE

It lies on the lower part of the inner aspect of the anterior thoracic wall. It arises from the lower 1/3 of the posterior surface of the sternum. Its fibres pass upwards and laterally to be inserted into the costal cartilages from 2nd to 6th.

1. costal cartilages (inner aspect).
2. sternocostalis muscle (posterior aspect).

* Note that the lower border of the muscle is horizontal while its upper border is more vertical.

Fig.(123): RELATIONS OF STERNOCOSTALIS
(seen from the thoracic cavity)

The sternocostalis intervenes between the parietal pleura (behind) and the internal thoracic artery as well as the terminations of the intercostal nerves (in front).

1. internal thoracic artery.
2. intercostal nerves.
3. posterior aspect of the sternocostalis muscle.
4. termination of the internal thoracic artery.

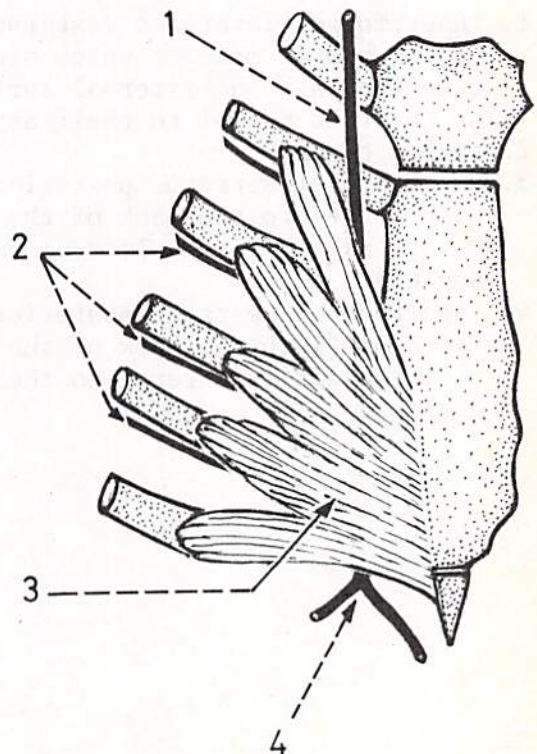


Fig.(124): SERRATUS POSTERIOR SUPERIOR AND SERRATUS POSTERIOR INFERIOR MUSCLES

These 2 muscles lie on the posterior aspect of the chest wall (one above and one below), and are supplied by ventral primary rami of the thoracic nerves.

1. serratus posterior superior (quadri-lateral and its fibres pass downwards and laterally deep to the rhomboideus muscles).
2. serratus posterior inferior (quadri-lateral and its fibres pass upwards and laterally deep to the latissimus dorsi).

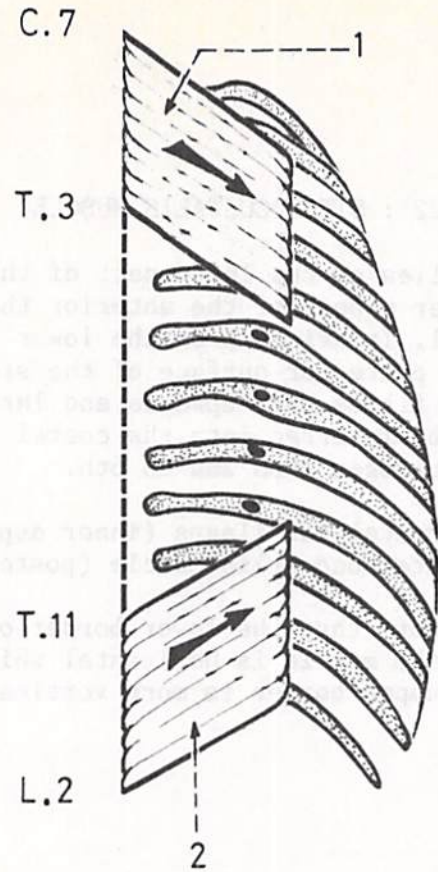
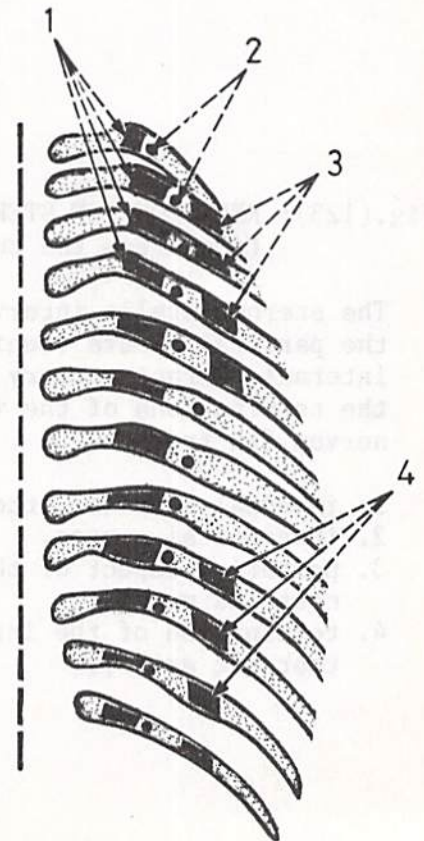


Fig.(125): INSERTIONS OF LEVATORES COSTARUM AND SERRATI POSTERIOR MUSCLES

1. insertion of levatores costarum (these are 12 muscles which are inserted into the external surfaces of the ribs medial to their angles).
2. angles of ribs.
3. insertion of serratus posterior superior (into the back of the 2nd to 5th ribs a little lateral to their angles).
4. insertion of serratus posterior inferior (into the back of the lower 4 ribs a little lateral to their angles).



MUSCLES OF THE BACK

The muscles of the back are arranged into 4 layers of which the superficial 2 layers belong to the upper limb and the chest wall, while the deep 2 layers are the intrinsic muscles of the back.

Fig.(126): MUSCLES OF THE 1st LAYER OF THE BACK

These are the trapezius and latissimus dorsi. They are muscles of the upper limb and are supplied by ventral primary rami of spinal nerves.

1. trapezius.
2. latissimus dorsi.

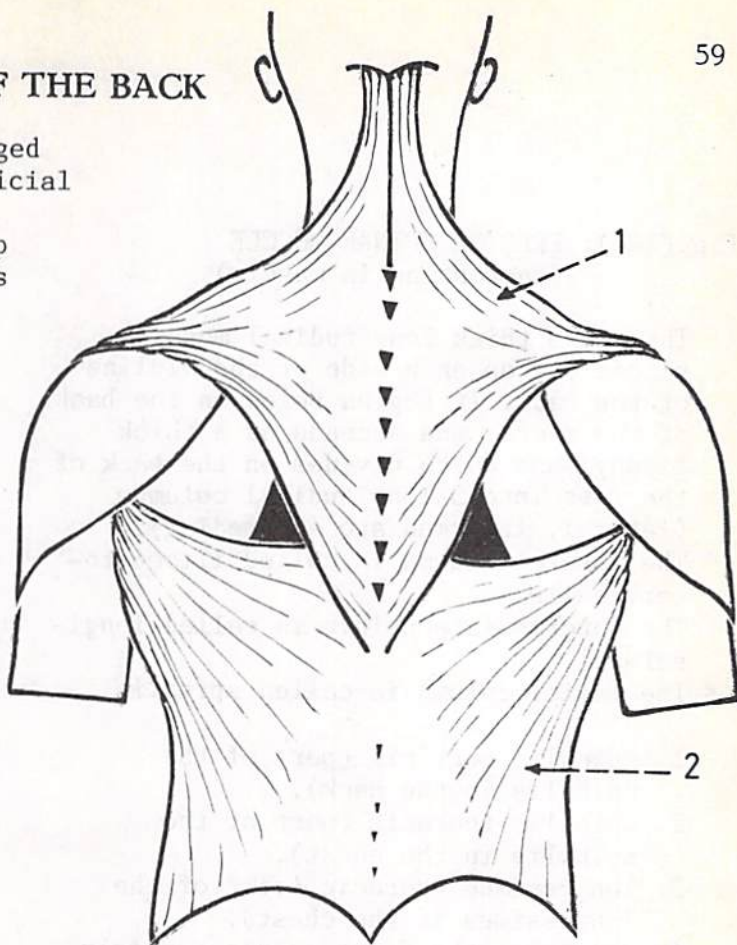


Fig.(127): MUSCLES OF THE 2nd LAYER OF THE BACK

These muscles belong to the upper limb (levator scapulae and the 2 rhomboids) as well as to the chest wall (serratus posterior superior and serratus posterior inferior). All these muscles are supplied by the ventral primary rami of spinal nerves.

1. levator scapulae.
2. rhomboideus minor and major (they overlie the serratus posterior superior).
3. serratus posterior inferior.

* In contrast to the superficial 2 layers which are supplied by the ventral primary rami, the deep 2 layers are supplied by the dorsal primary rami.

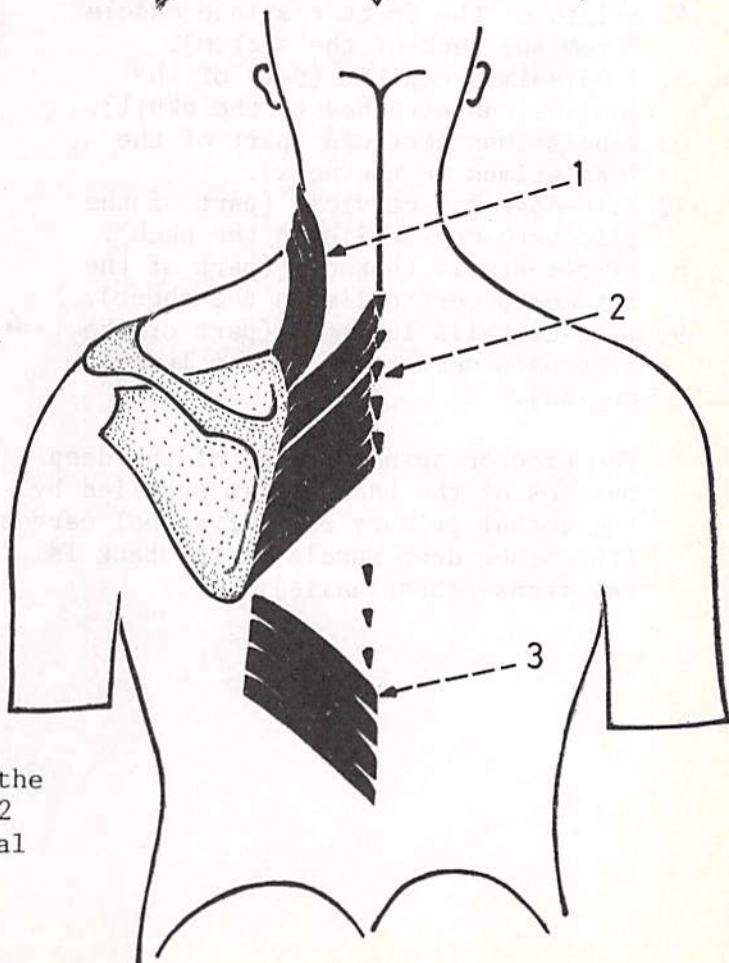


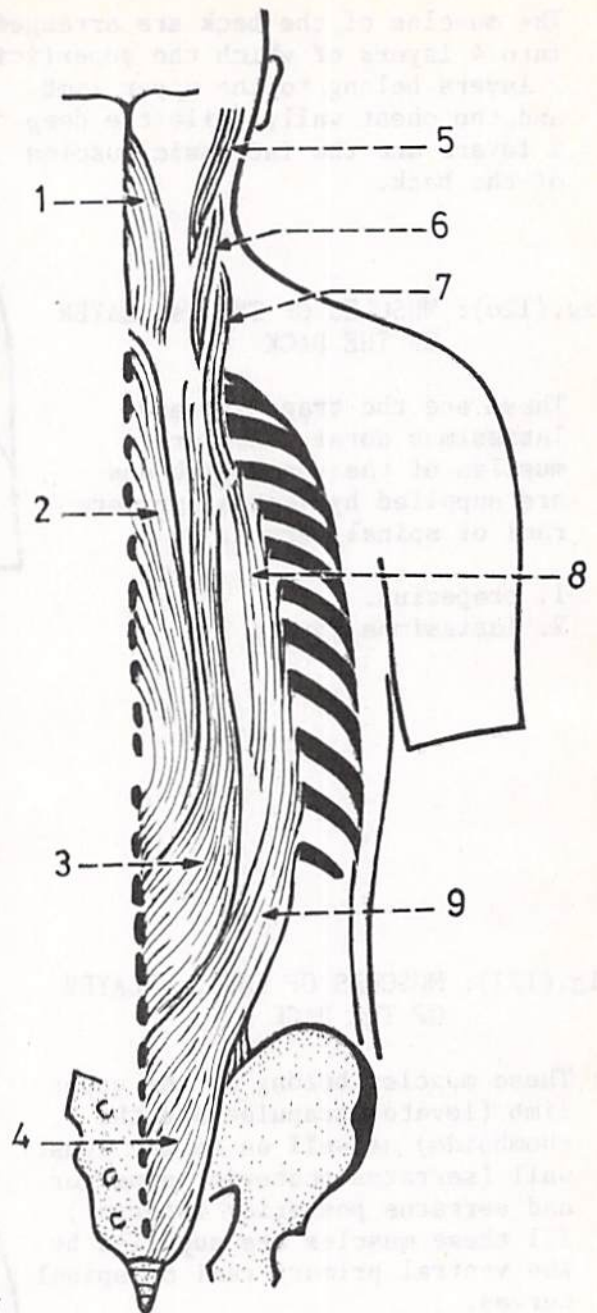
Fig.(128): ERECTOR SPINAE MUSCLE
(sacrospinalis muscle)

This is a thick longitudinal muscle placed one on each side of the midline of the back. It begins below on the back of the sacrum and ascends as a thick fleshy mass which divides on the back of the ribs into 3 longitudinal columns (lateral, intermediate and medial).

- * The lateral column is called iliocostocervicalis.
- * The intermediate column is called longissimus.
- * The medial column is called spinalis.

1. spinalis cervicis (part of the spinalis in the neck).
2. spinalis thoracis (part of the spinalis in the chest).
3. longissimus thoracic (part of the longissimus in the chest).
4. origin of the erector spinae muscle (from the back of the sacrum).
5. longissimus capitis (part of the longissimus attached to the skull).
6. longissimus cervicis (part of the longissimus in the neck).
7. ilio-costalis cervicis (part of the iliocostocervicalis in the neck).
8. ilio-costalis thoracis (part of the iliocostocervicalis in the chest).
9. ilio-costalis lumborum (part of the iliocostocervicalis in the lumbar region).

- * The erector spinae is one of the deep muscles of the back and is supplied by the dorsal primary rami of spinal nerves (the other deep muscle of the back is the transversospinalis).



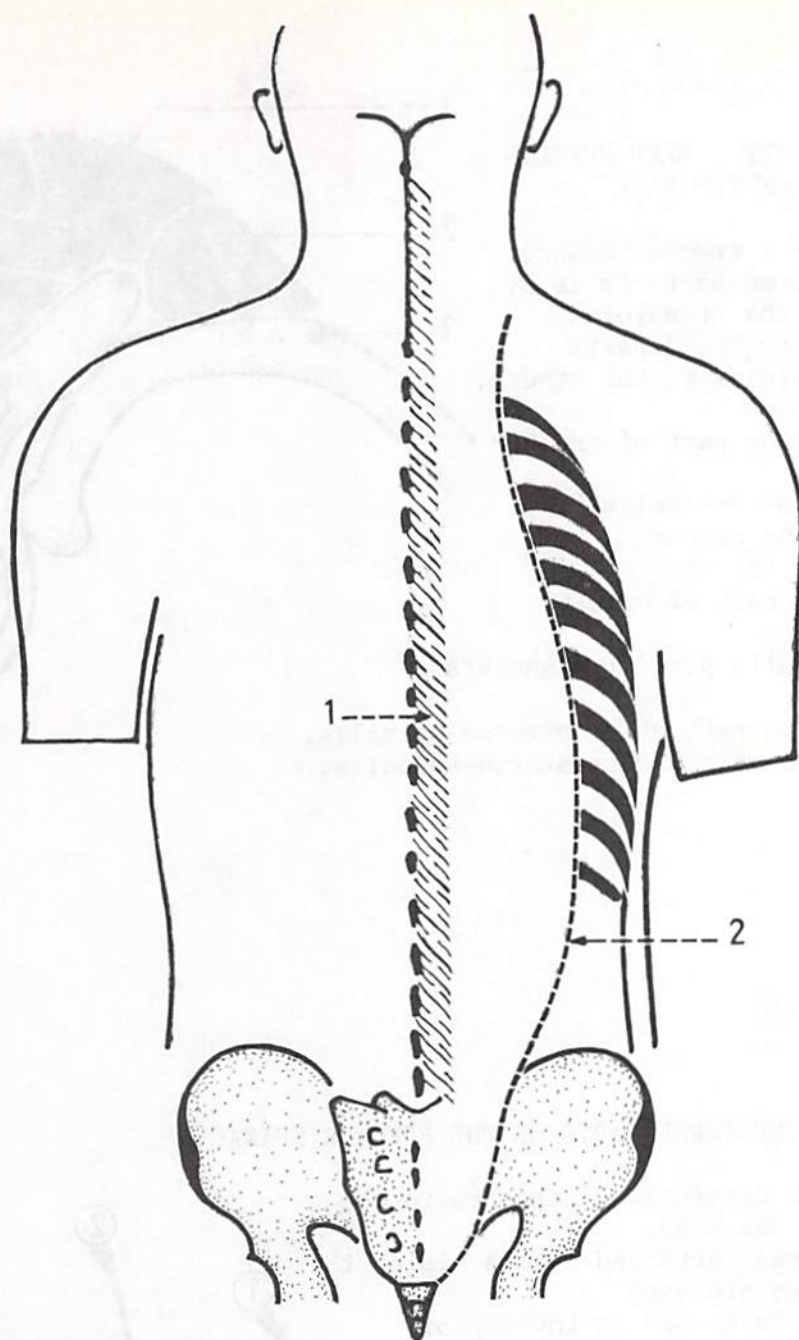


Fig.(129): TRANSVERSOSPINALIS MUSCLE

This muscle is one of the deep muscles of the back (4th layer) which lies deep to the erector spinae (3rd layer). It consists of 3 groups of short muscles which run obliquely upwards and medially from the transverse processes to the spines and laminae of the vertebrae (hence its name transverso-spinalis). These 3 groups are called semispinalis (superficial), multifidus (in the middle) and rotatores (deepest). It is supplied by the dorsal primary rami of spinal nerves.

1. transversospinalis (the deepest muscle of the back).
2. lateral border of the erector spinae muscle.

* Note that the 3 columns of the erector spinae lie side by side, while the 3 groups of the transversospinalis lie one superficial to the other.

Fig.(130): THE 2 DEEP MUSCLES
OF THE BACK

These are the erector spinae with its three parts (side by side), and the transversospinalis with its 3 parts (one superficial to the other).

1. longissimus part of erector spinae.
2. iliocosto-cervicalis part of erector spinae.
3. angle of the rib.
4. spinalis part of erector spinae.
5. semispinalis part of transversospinalis.
6. multifidus part of transversospinalis.
7. rotatores part of transversospinalis.

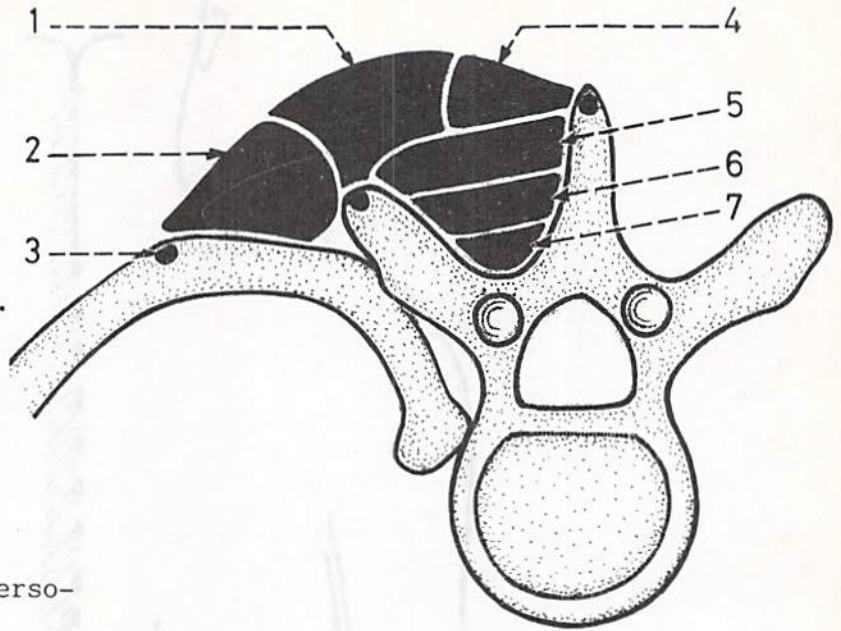


Fig.(131): THE THREE PARTS OF THE ERECTOR SPINAE

1. iliocosto-cervicalis (attached to the angle of the rib).
2. longissimus (attached to the tip of the transverse process).
3. spinalis (attached to the tip of the spine).

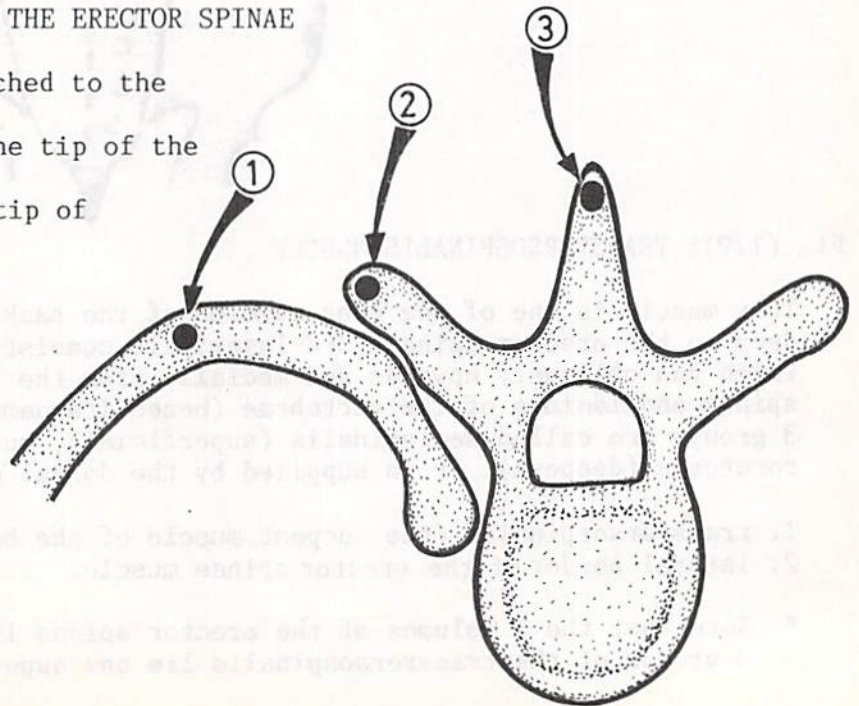


Fig.(132): THE THREE PARTS OF THE TRANSVERSOSPINALIS

1. semispinalis (most superficial and is inserted into the tip of the spine).
2. multifidus (in the middle and is inserted into the side of the spine).
3. rotatores (the deepest and is inserted into the lamina).
4. common origin of the 3 parts of the muscle from the transverse process of the vertebra below.

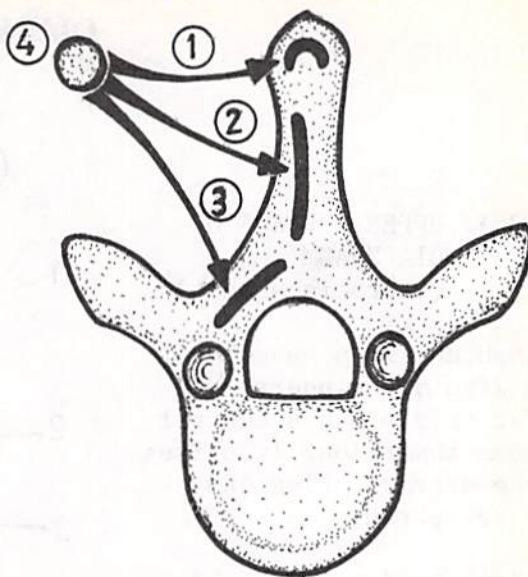


Fig.(133): DIRECTION OF FIBRES OF THE TRANSVERSOSPINALIS

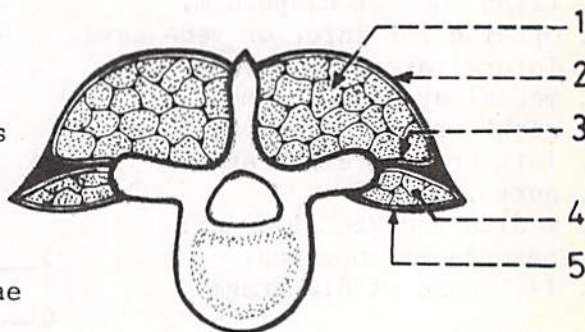
The fibres run obliquely upwards and medially from the transverse processes to the spines and laminae of the vertebrae above.



Fig.(134): THORACOLUMBAR FASCIA

It is thick deep fascia formed of 3 layers which surround the deep muscles of the back as well as the quadratus lumborum muscle.

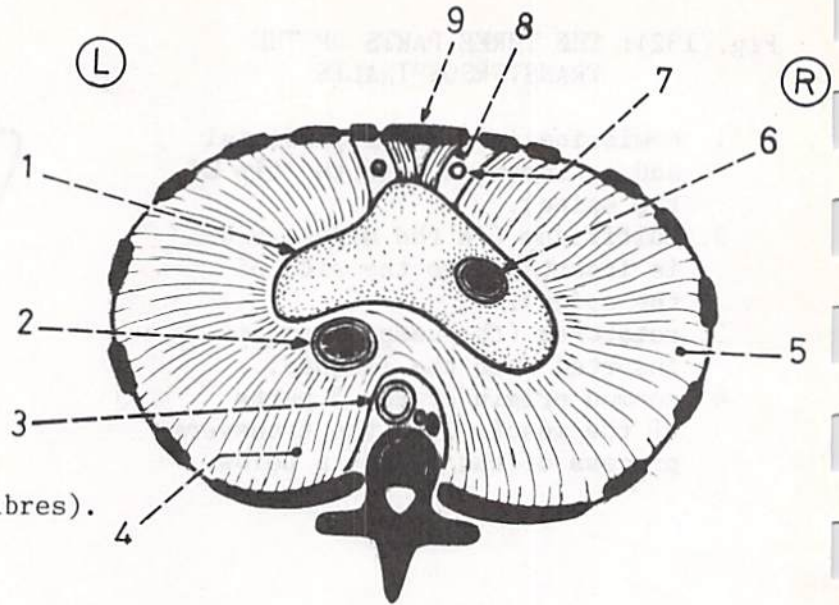
1. deep muscles of the back (erector spinae and transversospinalis).
2. posterior layer of thoracolumbar fascia.
3. middle layer of thoracolumbar fascia.
4. quadratus lumborum muscle (a muscle of the posterior abdominal wall).
5. anterior layer of thoracolumbar fascia.



DIAPHRAGM

Fig.(135): UPPER SURFACE OF
DIAPHRAGM
(thoracic aspect)

The diaphragm is a muscular septum with a peripheral muscular origin and a central tendinous insertion. It arises from the sternum, ribs and lumbar vertebrae.



1. central tendon of diaphragm
(for insertion of its muscle fibres).
2. oesophageal opening.
3. aortic opening.
4. lumbar origin of diaphragm.
5. costal origin of diaphragm
(from lower 6 costal cartilages).
6. opening for inferior vena cava.
7. superior epigastric artery.
8. sternal origin of diaphragm
(from xiphoid process).
9. xiphoid process.

Fig.(136): LOWER SURFACE OF
DIAPHRAGM
(abdominal aspect)

This diagram shows the lumbar origin of diaphragm which consists of 2 crura and 5 arcuate ligaments.

1. right dome of diaphragm.
2. opening for inferior vena cava.
3. lateral arcuate ligament.
4. medial arcuate ligament.
5. right crus of diaphragm.
6. left crus of diaphragm.
7. aorta.
8. median arcuate ligament.
9. oesophageal opening.
10. left dome of diaphragm.

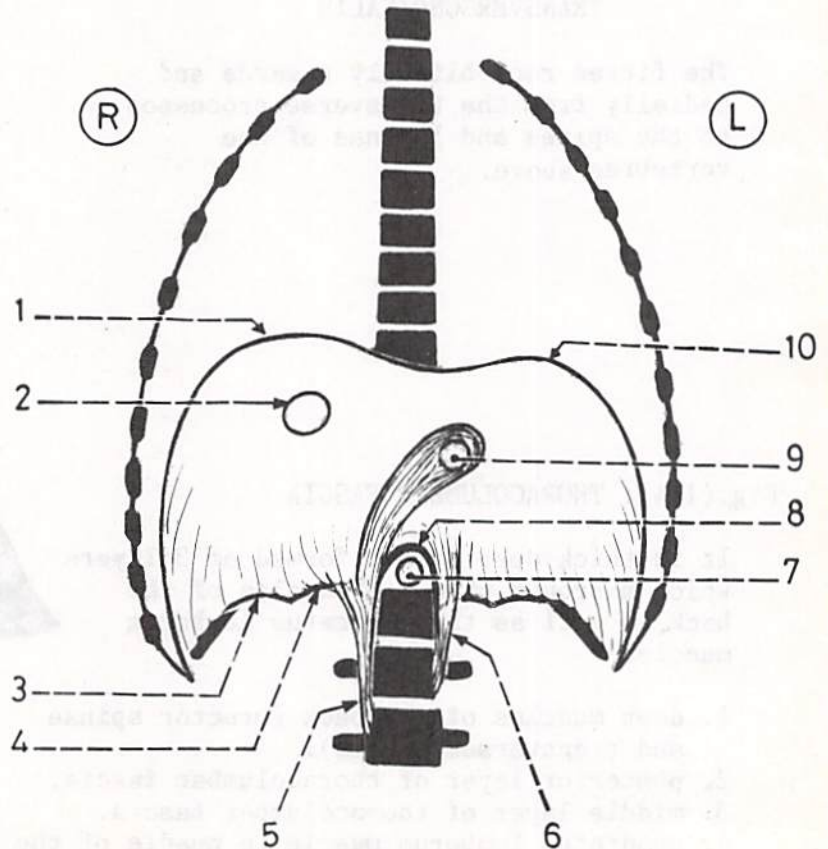


Fig.(137): ORIGIN AND INSERTION OF DIAPHRAGM
(side view)

The diaphragm arises from the sternum, lower 6 costal cartilages and the upper 3 lumbar vertebrae. It is inserted into the central tendon which lies near the centre of the diaphragm.

1. level of the uppermost part of the diaphragm opposite the 4th costal cartilage.
2. sternal origin (from the back of the xiphoid process).
3. costal origin (from the lower 6 costal cartilages).
4. vertebral origin (from the upper 3 lumbar vertebrae).
5. costodiaphragmatic recess.
6. central tendon of diaphragm (insertion).

* Note that the central tendon is nearer to the anterior wall of the chest than to the posterior wall.

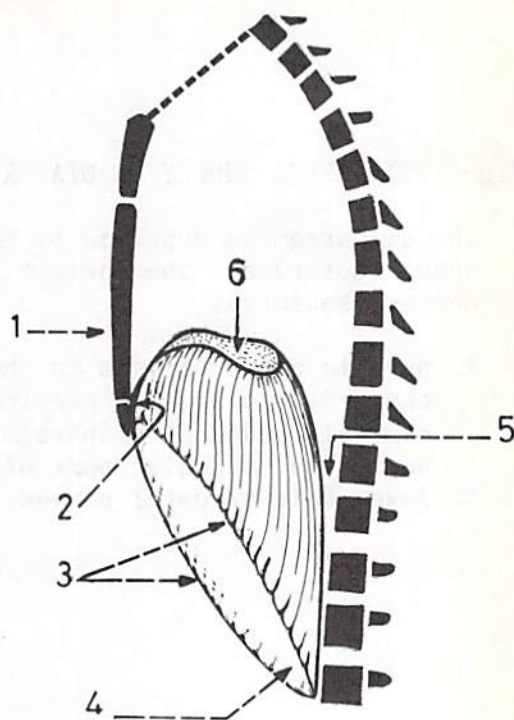


Fig.(138): RELATIONS OF THE DIAPHRAGM TO
MEDIASTINAL STRUCTURES

The central tendon of diaphragm lies directly below the base of pericardium to which it is attached. The posterior part of the diaphragm is nearly vertical and lies in front of the descending aorta and oesophagus.

1. base of fibrous pericardium.
2. central tendon of diaphragm.
3. descending thoracic aorta.
4. oesophagus.

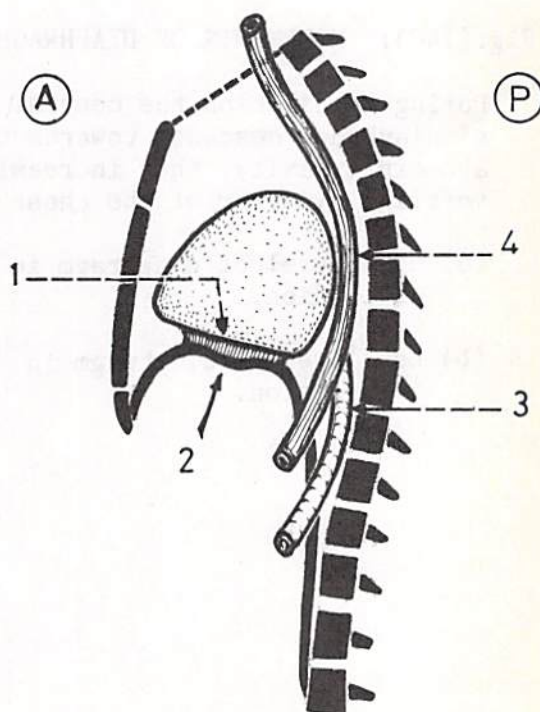


Fig.(139): NERVE SUPPLY OF DIAPHRAGM

The diaphragm is supplied by the phrenic nerve (motor) and the lower 6 intercostal nerves (sensory).

1. phrenic nerve (arises in the neck from the 3rd, 4th and 5th cervical roots).
2. central tendon of diaphragm.
3. peripheral muscular part of diaphragm.
4. lower 6 intercostal nerves.

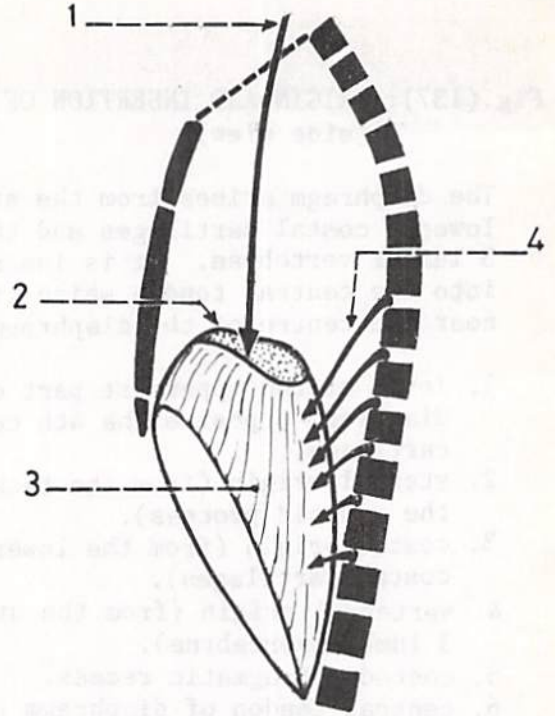
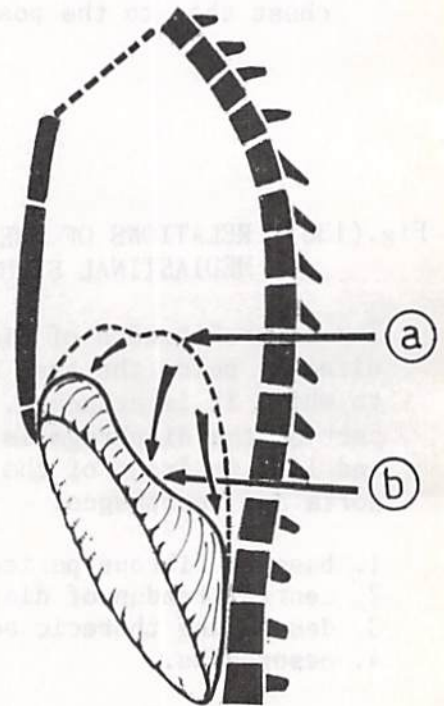


Fig.(140): MOVEMENTS OF DIAPHRAGM

During inspiration the central tendon of diaphragm descends towards the abdominal cavity, thus increasing the vertical diameter of the chest cavity.

- (a) High level of diaphragm in expiration.
- (b) Low level of diaphragm in inspiration.



INTERCOSTAL NERVES

67

Fig.(141): ARRANGEMENT OF INTERCOSTAL NERVES

The intercostal nerves are the ventral primary rami of the thoracic nerves. They run in the intercostal spaces and are arranged as follows:

- * 1st and 2nd nerves : supply the chest wall and upper limb (atypical).
- * 3rd to 6th nerves : supply only the chest wall, thus are called typical intercostal nerves.
- * 7th to 11th nerves : supply the chest wall and abdominal wall, thus called thoraco-abdominal nerves.
- * Note that the 12th thoracic nerve is called the subcostal nerve as it runs below the last rib; it supplies the abdominal wall but not the chest wall.
- * Note that the typical intercostal nerves are from 3 to 6, while all others are atypical.

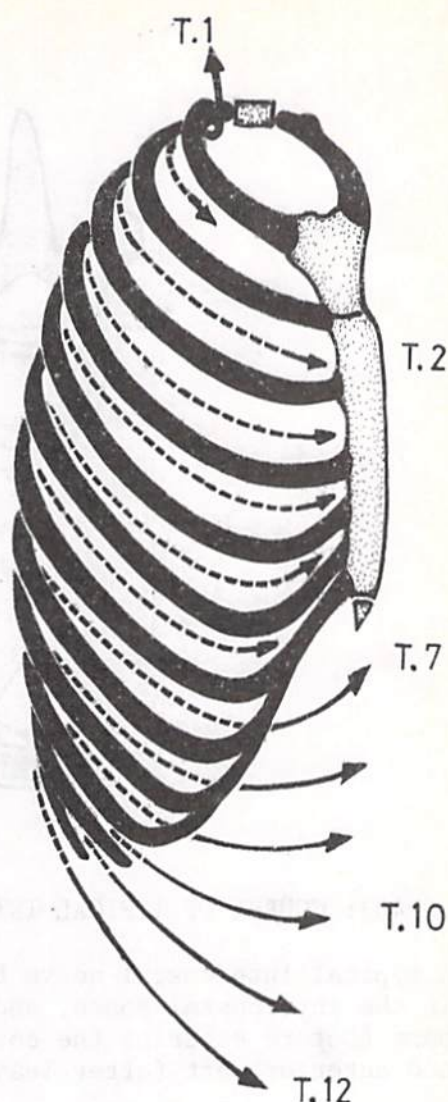
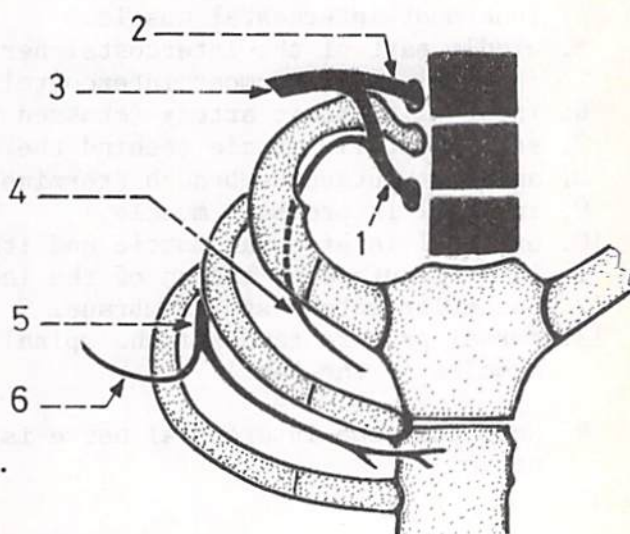


Fig.(142): 1st AND 2nd INTERCOSTAL NERVES

These 2 nerves differ from the typical intercostal nerves in the following:

- * The 1st intercostal nerve divides into 2 unequal parts of which the larger part ascends to join the lower trunk of brachial plexus.
- * The 2nd intercostal nerve has its lateral cutaneous branch undivided and is called the intercosto-brachial nerve.

1. 1st intercostal nerve.
2. 8th cervical nerve.
3. lower trunk of brachial plexus (C.8 and T.1).
4. termination of 1st intercostal nerve.
5. 2nd intercostal nerve.
6. intercostobrachial nerve (it is the lateral cutaneous branch of the 2nd intercostal nerve).



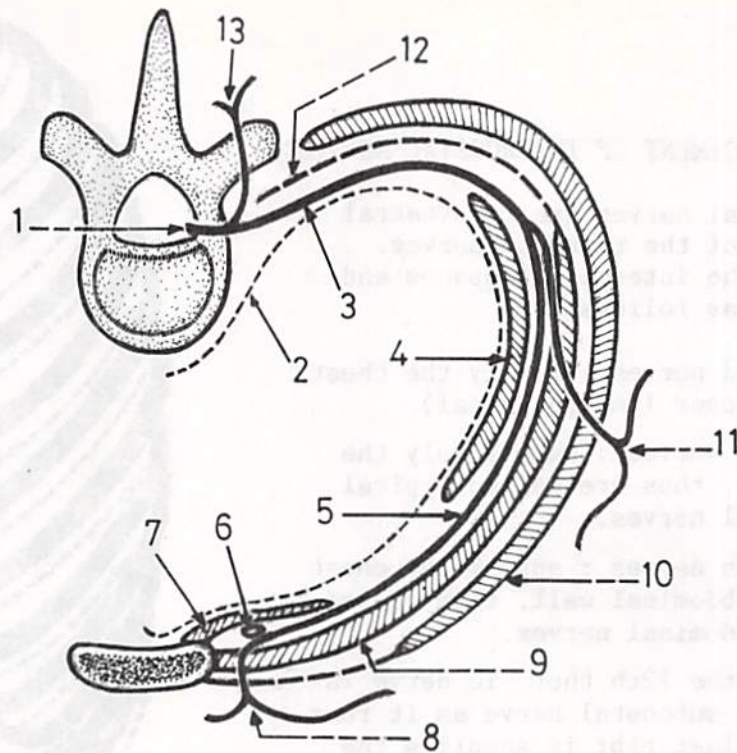


Fig.(143): COURSE OF TYPICAL INTERCOSTAL NERVE

A typical intercostal nerve belongs to the thoracic nerves from 3 to 6. It runs in the intercostal space, and its course can be divided into 3 parts: posterior part (before entering the costal groove), middle part (in the costal groove) and anterior part (after leaving the costal groove).

1. trunk of the spinal nerve (in the intervertebral foramen).
2. parietal pleura.
3. posterior part of intercostal nerve (between the parietal pleura and posterior intercostal membrane).
4. innermost intercostal muscle.
5. middle part of the intercostal nerve (in the costal groove between the internal and innermost intercostal muscles).
6. internal thoracic artery (crossed by the anterior part of the nerve).
7. sternocostalis muscle (behind the anterior part of the nerve).
8. anterior cutaneous branch (termination of the intercostal nerve).
9. internal intercostal muscle.
10. external intercostal muscle and its anterior intercostal membrane.
11. lateral cutaneous branch of the intercostal nerve.
12. posterior intercostal membrane.
13. dorsal primary ramus of the spinal nerve (runs backwards to supply the deep muscles of the back).

* Note that the intercostal nerve is the ventral primary ramus of the spinal nerve.

Fig.(144): BRANCHES OF TYPICAL INTERCOSTAL NERVE

The typical intercostal nerve gives off the following branches:
collateral, lateral cutaneous, anterior cutaneous, muscular and ganglionic.

1. sympathetic trunk.
2. 2 ganglionic branches connecting the sympathetic ganglion with the intercostal nerve.
3. intercostal nerve.
4. lateral cutaneous branch (arises close to the angle of the rib and divides into anterior and posterior divisions).
5. collateral branch (arises close to the angle of the rib and runs forwards in the lower part of the intercostal space).
6. continuation of the intercostal nerve.
7. anterior cutaneous branch (the termination of the intercostal nerve).

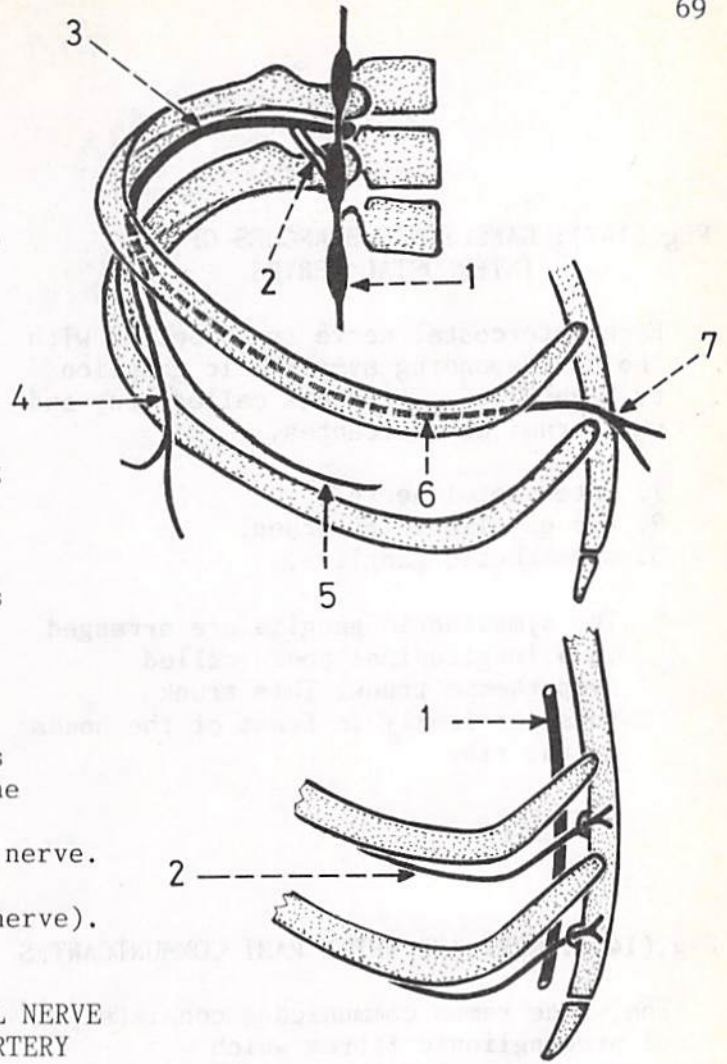


Fig.(145): RELATION OF THE INTERCOSTAL NERVE TO THE INTERNAL THORACIC ARTERY

The termination of the typical intercostal nerve crosses in front of the internal thoracic artery close to the sternum.

1. internal thoracic artery.
2. intercostal nerve.

Fig.(146): POSITION OF THE NERVE IN THE INTERCOSTAL SPACE

The intercostal nerve and its collateral branch run in the neurovascular plane between the internal and innermost intercostal muscles.

1. parietal pleura.
2. posterior intercostal vessels.
3. innermost intercostal muscle.
4. intercostal nerve (along the upper border of the space).
5. neurovascular plane.
6. collateral branch (along the lower border of the space).
7. internal intercostal muscle.
8. external intercostal muscle.

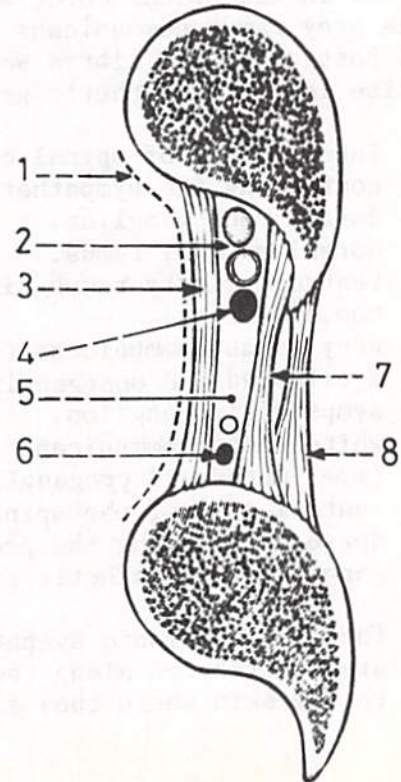


Fig.(147): GANGLIONIC BRANCHES OF INTERCOSTAL NERVES

Each intercostal nerve is connected with the corresponding sympathetic ganglion by 2 ganglionic branches called grey and white rami communicantes.

1. intercostal nerve.
2. two ganglionic branches.
3. sympathetic ganglion.

* The sympathetic ganglia are arranged in a longitudinal chain called sympathetic trunk. This trunk runs vertically in front of the heads of the ribs.

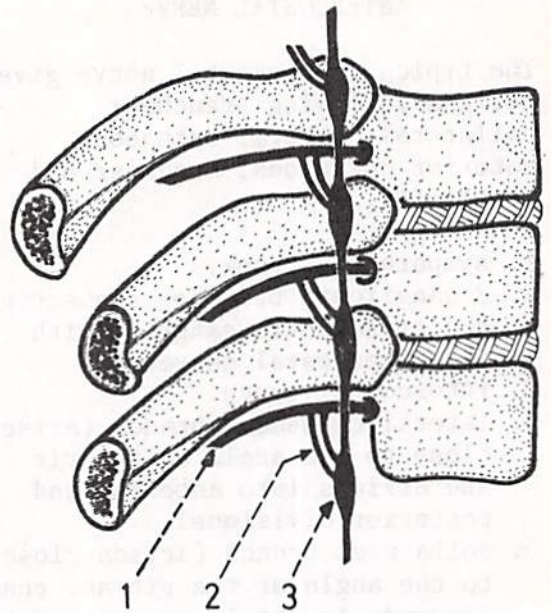
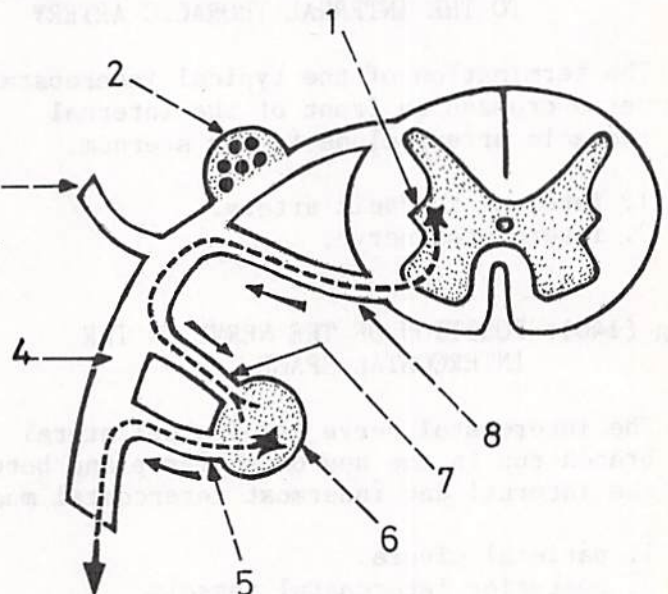


Fig.(148): GREY AND WHITE RAMI COMMUNICANTES

The white ramus communicans consists of preganglionic fibres which arise in the spinal cord, while the grey ramus communicans consists of postganglionic fibres which arise in the sympathetic ganglion.

1. lateral horn of spinal cord containing the sympathetic cells.
2. dorsal root ganglion.
3. dorsal primary ramus.
4. ventral primary ramus (intercostal nerve).
5. grey ramus communicans (non-myelinated and postganglionic).
6. sympathetic ganglion.
7. white ramus communicans (myelinated and preganglionic).
8. ventral root of the spinal nerve (containing the preganglionic sympathetic fibres).



* The postganglionic sympathetic fibres are distributed along the cutaneous branches of the intercostal nerves to the skin where they supply mainly the sweat glands and blood vessels.

ARTERIES OF THE CHEST WALL

INTERNAL THORACIC ARTERY

Fig.(149): COURSE OF INTERNAL THORACIC ARTERY

The artery arises in the neck from the 1st part of subclavian artery. It passes at first downwards and medially, then it descends vertically behind the upper 6 costal cartilages 1 cm from the lateral margin of the sternum. It ends at the 6th intercostal space by dividing into musculophrenic and superior epigastric arteries.

1. 1st part of subclavian artery.
2. oblique part of the internal thoracic artery (in the root of the neck).
3. vertical part of the internal thoracic artery (in the chest cavity).
4. musculophrenic artery.
5. superior epigastric artery.
6. termination of the internal thoracic artery.

* The internal thoracic artery is also known as the internal mammary artery.

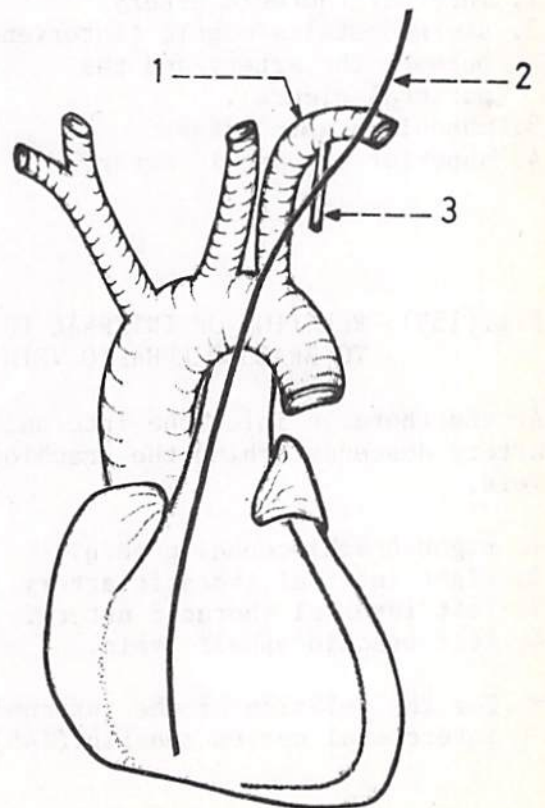
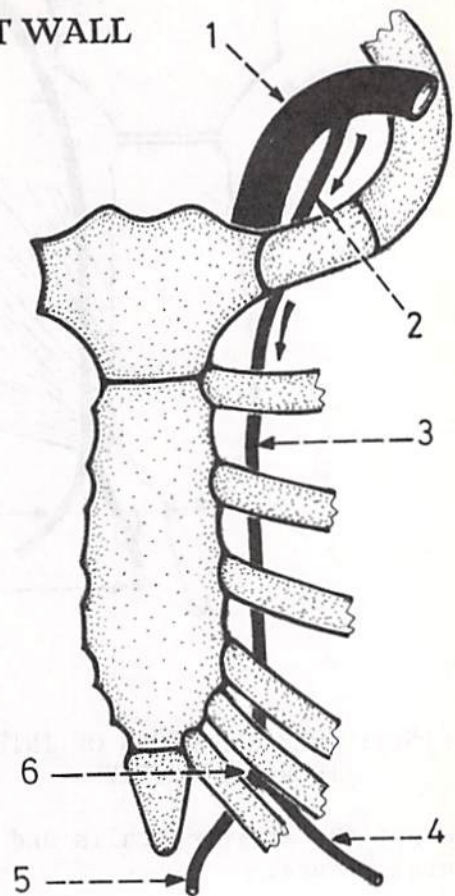


Fig.(150): RELATION OF INTERNAL THORACIC ARTERY TO THE PHRENIC NERVE

At the beginning of the artery (in the thoracic inlet) it is crossed in front by the phrenic nerve from lateral to medial.

1. first part of subclavian artery.
2. phrenic nerve.
3. internal thoracic artery in the thoracic inlet (crossed by the phrenic nerve from lateral to medial).

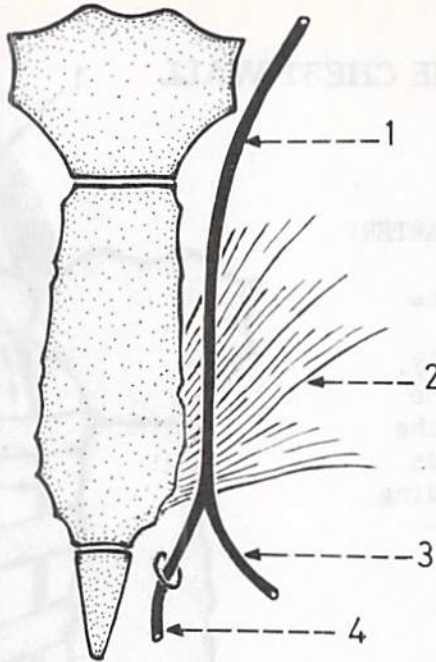


Fig.(151): DEEP RELATIONS OF INTERNAL THORACIC ARTERY

These are the sternocostalis and parietal pleura.

1. internal thoracic artery.
2. sternocostalis muscle (intervenes between the artery and the parietal pleura).
3. musculophrenic artery.
4. superior epigastric artery.

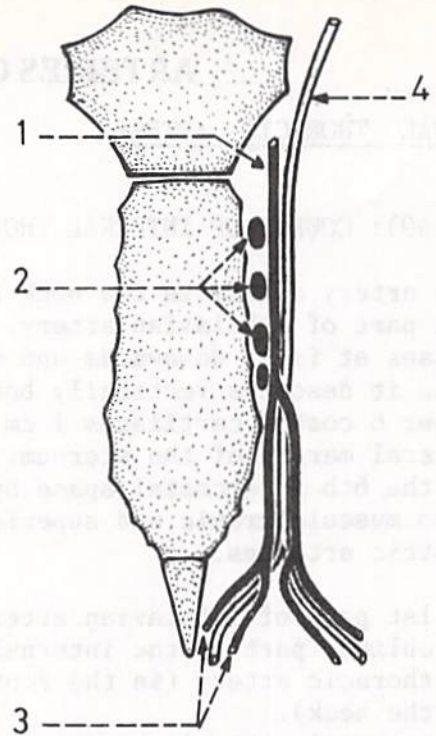


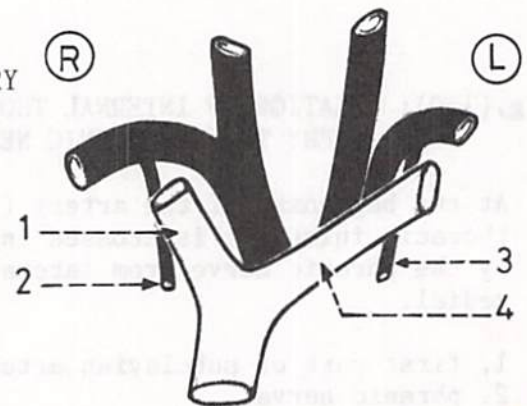
Fig.(152): SIDE RELATIONS OF INTERNAL THORACIC ARTERY

1. internal thoracic vein (medial to the artery).
2. parasternal lymph nodes.
3. venae comitantes.
4. internal thoracic artery.

Fig.(153): RELATION OF INTERNAL THORACIC ARTERY TO BRACHIOCEPHALIC VEIN

At the thoracic inlet, the internal thoracic artery descends behind the brachiocephalic vein.

1. right brachiocephalic vein.
2. right internal thoracic artery.
3. left internal thoracic artery.
4. left brachiocephalic vein.



* For the relation of the internal thoracic artery to the terminations of the intercostal nerves see fig.(145).

Fig.(154): BRANCHES OF INTERNAL THORACIC ARTERY

These are the following: pericardiaco-phrenic, perforating, anterior intercostal, musculophrenic and superior epigastric.

1. internal thoracic artery.
2. pericardiaco-phrenic artery (descends in company with the phrenic nerve).
3. phrenic nerve.
4. diaphragm.
5. musculophrenic artery (passes downwards and laterally behind the 7th, 8th and 9th costal cartilages and then perforates the diaphragm to enter the anterior abdominal wall).
6. superior epigastric artery (descends vertically into the rectus sheath).
7. termination of internal thoracic artery (at the 6th space).
8. costal cartilages.
9. anterior intercostal arteries (2 branches in each space).
10. perforating branches (perforate the intercostal muscles to reach the pectoral region).

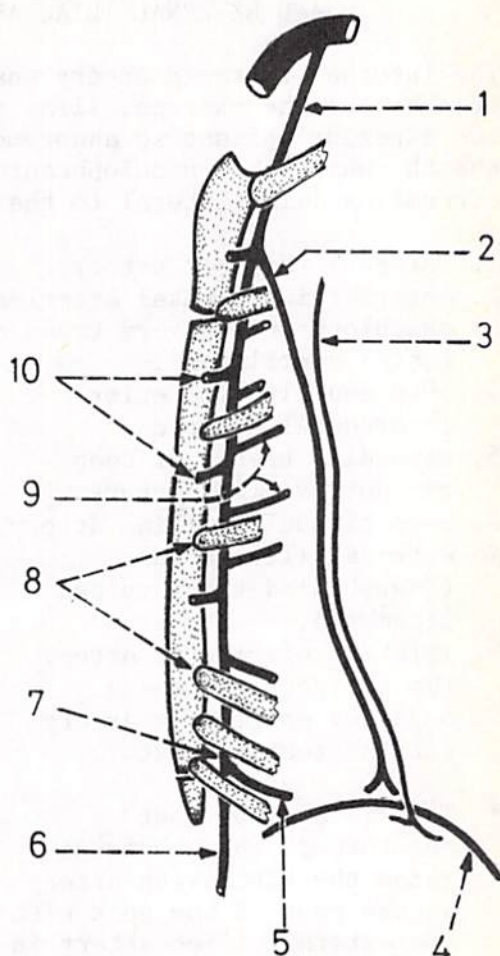


Fig.(155): ANASTOMOSIS BETWEEN THE 2 INTERNAL THORACIC ARTERIES AND THE DESCENDING AORTA

The 2 internal thoracic arteries anastomose with the descending aorta through their anterior and posterior intercostal branches which run in the intercostal spaces.

1. right and left internal thoracic arteries.
2. two anterior intercostal arteries.
3. posterior intercostal artery and its collateral branch.
4. descending thoracic aorta.

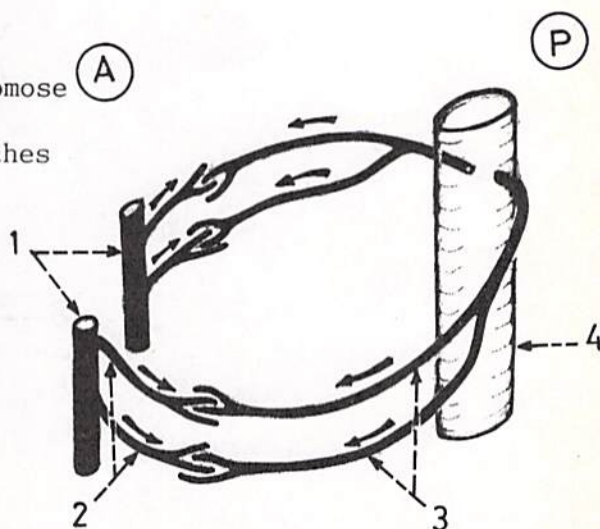
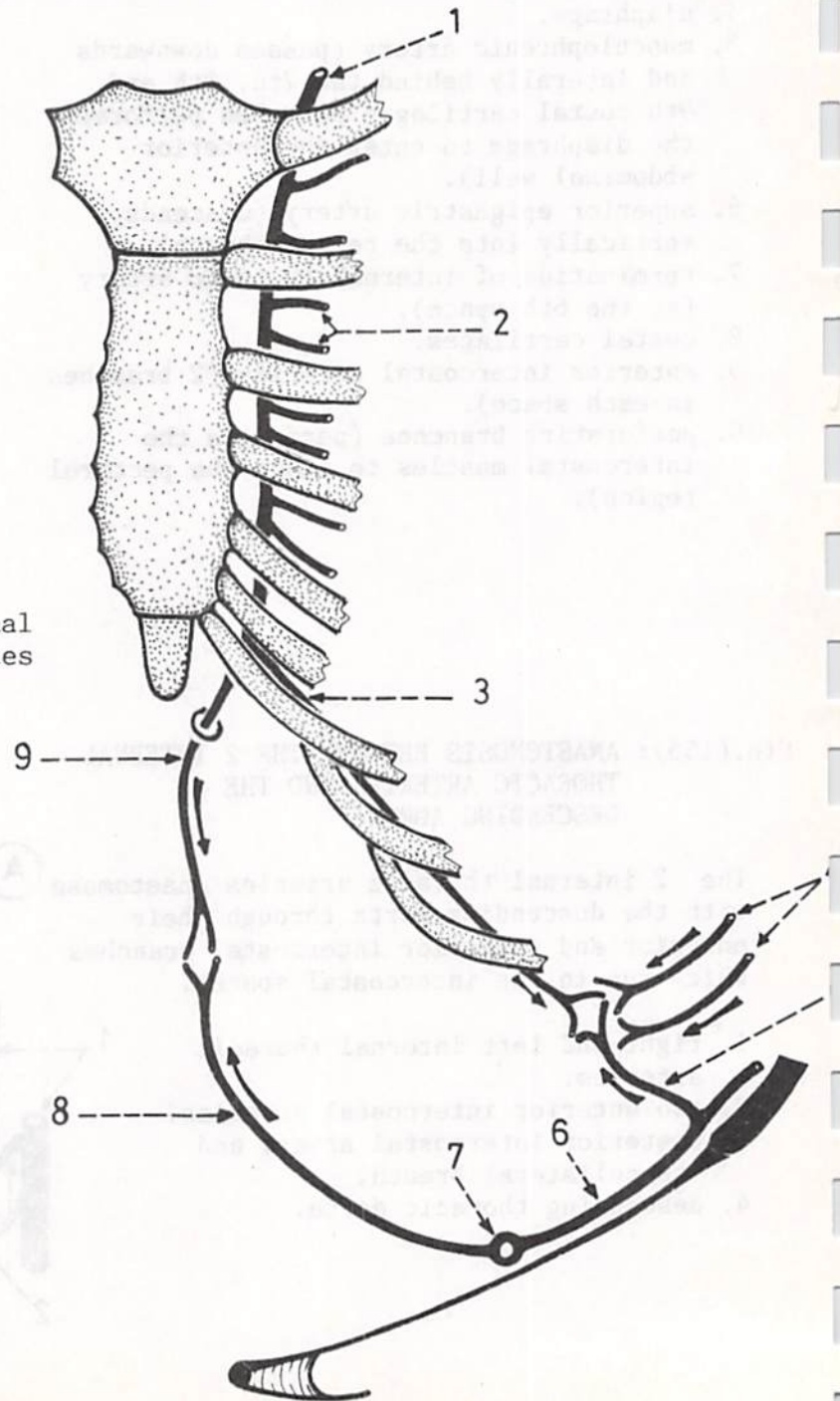


Fig.(156): ANASTOMOSIS BETWEEN THE INTERNAL THORACIC
AND EXTERNAL ILIAC ARTERIES

The internal thoracic artery anastomoses by its 2 terminal branches with the 2 branches of the external iliac artery in the abdominal wall as follows: the superior epigastric anastomoses with the inferior epigastric in the rectus sheath, while the musculophrenic anastomoses with the ascending branch of the deep circumflex iliac lateral to the rectus sheath.

1. internal thoracic artery.
2. anterior intercostal arteries.
3. musculophrenic artery (runs downwards and laterally behind the 7th, 8th and 9th costal cartilages).
4. 10th and 11th posterior intercostal arteries.
5. ascending branch of deep circumflex iliac artery.
6. deep circumflex iliac artery.
7. external iliac artery (just behind the inguinal ligament).
8. inferior epigastric artery (in the rectus sheath).
9. superior epigastric artery (in the rectus sheath).

* This is an important anastomosis which communicates the subclavian artery in the root of the neck with the external iliac artery in the lower part of the abdominal cavity. It is one of the routes for collateral circulation in case of coarctation (narrowing) of the aorta.



POSTERIOR INTERCOSTAL ARTERIES

Fig.(157): ORIGIN OF POSTERIOR INTERCOSTAL ARTERIES

The 1st and 2nd arteries arise from the superior intercostal artery which is a branch of the costocervical trunk. The remaining intercostal arteries and the subcostal arise from the back of the descending thoracic aorta.

1. first part of subclavian artery.
2. costocervical trunk (from 2nd part of subclavian artery).
3. superior intercostal artery (descends in front of the neck of 1st rib and ends by dividing into the posterior intercostal arteries for the first 2 spaces).
4. 1st posterior intercostal artery.
5. 2nd posterior intercostal artery.
6. 3rd posterior intercostal artery (the highest branch from the descending aorta).
7. arch of the aorta.
8. descending thoracic aorta.

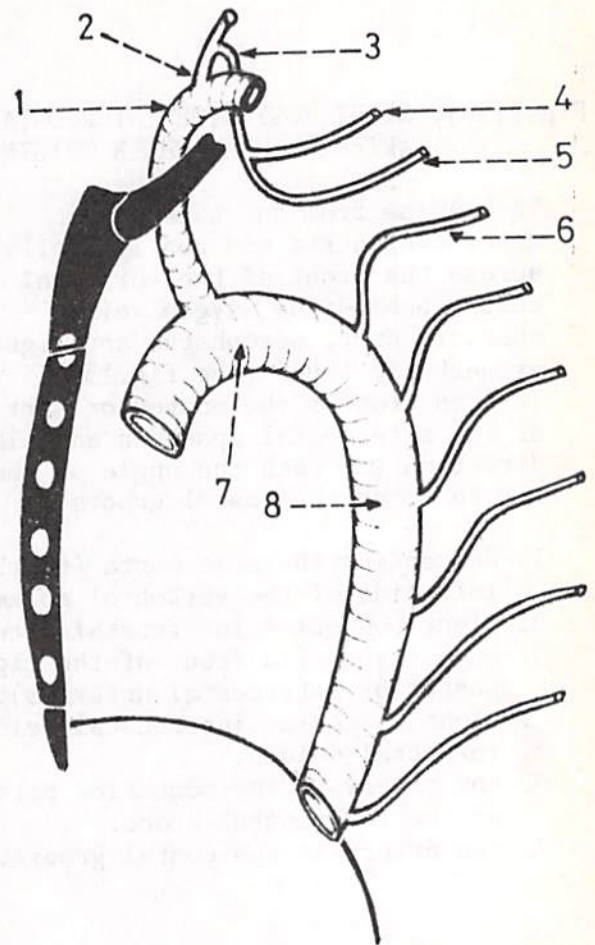


Fig.(158): THE RIGHT AND LEFT POSTERIOR INTERCOSTAL ARTERIES NEAR THEIR ORIGIN

The arteries of both sides arise from the back of the descending thoracic aorta which lies on the left side of the vertebral column. The left intercostal arteries run laterally behind the hemiazygos veins and left sympathetic trunk before reaching the intercostal space. The right arteries are longer and cross over the vertebrae behind the oesophagus, azygos vein, thoracic duct and right sympathetic trunk before reaching the intercostal space.

1. right sympathetic trunk.
2. azygos vein.
3. thoracic duct.
4. oesophagus.
5. descending thoracic aorta.
6. hemiazygos vein.
7. left sympathetic trunk.

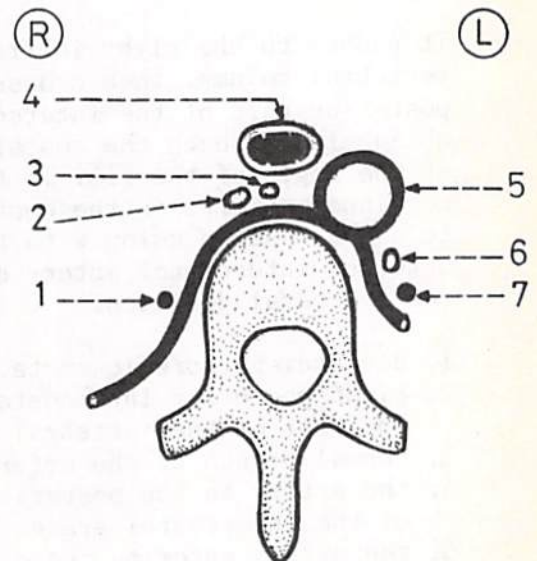


Fig.(159): RIGHT POSTERIOR INTERCOSTAL ARTERIES NEAR THEIR ORIGIN

They arise from the back of the descending aorta and run laterally across the front of the vertebral column behind the azygos vein, thoracic duct, oesophagus and right sympathetic trunk (see fig.158). It then crosses the posterior part of the intercostal space in an oblique direction to reach the angle of the rib to enter the costal groove.

1. descending thoracic aorta (on the left side of the vertebral column).
2. right posterior intercostal artery.
3. azygos vein (in front of the right posterior intercostal arteries).
4. right posterior intercostal vein.
5. vertebral column.
6. the artery in the posterior part of the intercostal space.
7. the artery in the costal groove.

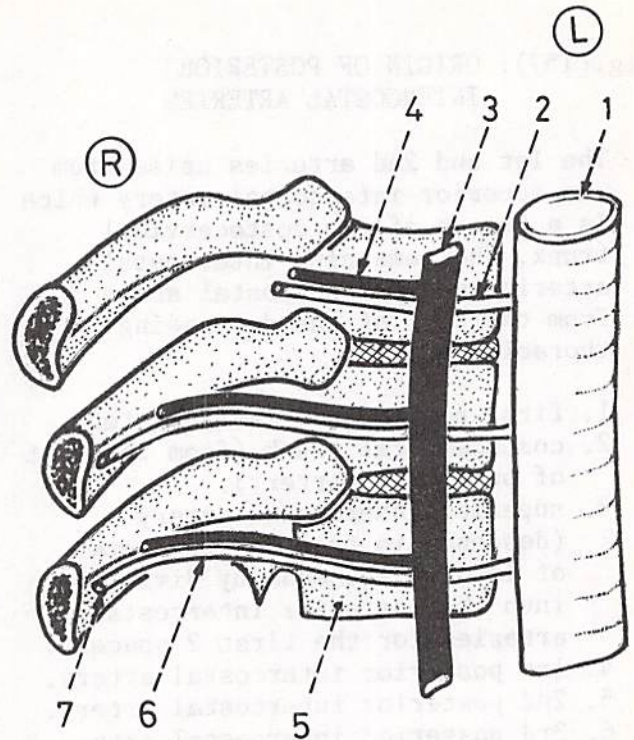


Fig.(160): COURSE OF THE RIGHT POSTERIOR INTERCOSTAL ARTERY

It passes to the right in front of the vertebral column, then crosses the posterior part of the intercostal space obliquely to reach the costal groove at the angle of the rib. It then continues onwards in the costal groove to end by anastomosing with the anterior intercostal artery at the costochondral junction.

1. descending thoracic aorta.
2. right posterior intercostal artery in front of the vertebral column.
3. dorsal branch of the artery.
4. the artery in the posterior part of the intercostal space.
5. the artery entering the costal groove at the angle of the rib.
6. the artery in the costal groove.
7. collateral branch of the artery.
8. anterior intercostal arteries.
9. internal thoracic artery.

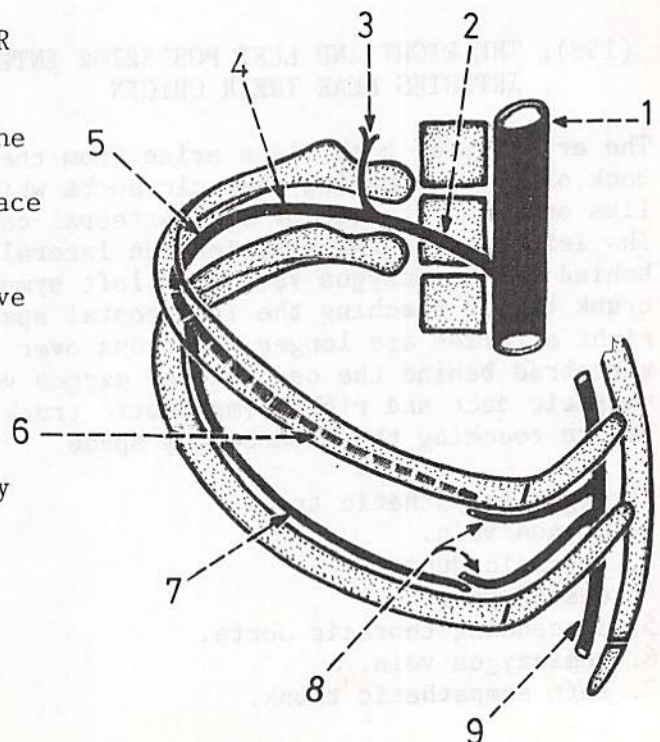


Fig.(161): RELATIONS OF THE RIGHT POSTERIOR INTERCOSTAL ARTERIES NEAR THEIR ORIGIN

The arteries run behind the oesophagus, azygos vein and right sympathetic trunk.

1. right posterior intercostal arteries.
2. right sympathetic trunk (passes vertically in front of the heads of the ribs).
3. oesophagus.
4. azygos vein.

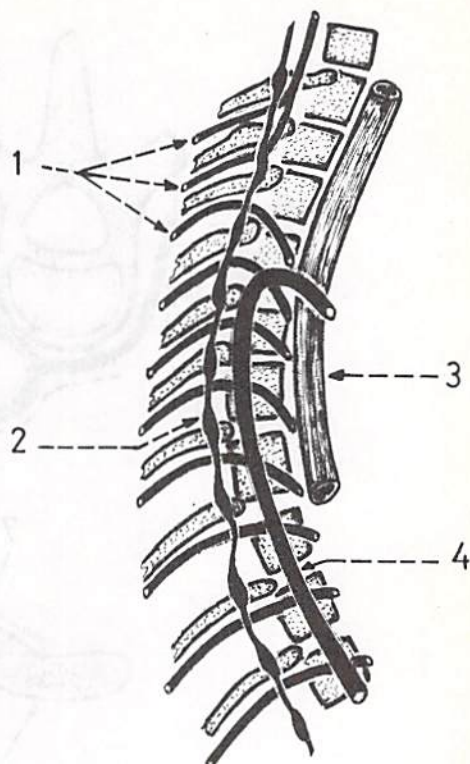
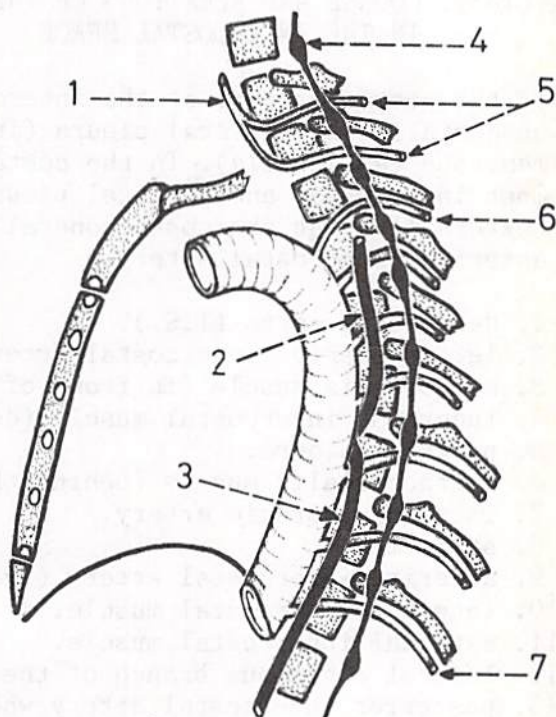


Fig.(162): RELATIONS OF THE LEFT POSTERIOR INTERCOSTAL ARTERIES NEAR THEIR ORIGIN

The arteries run behind the hemiazygos veins and left sympathetic trunk.

1. superior intercostal artery.
2. superior hemiazygos vein.
3. inferior hemiazygos vein.
4. left sympathetic trunk.
5. left posterior intercostal arteries for the 1st and 2nd spaces (from the superior intercostal artery).
6. 3rd left posterior intercostal artery.
7. 9th left posterior intercostal artery.



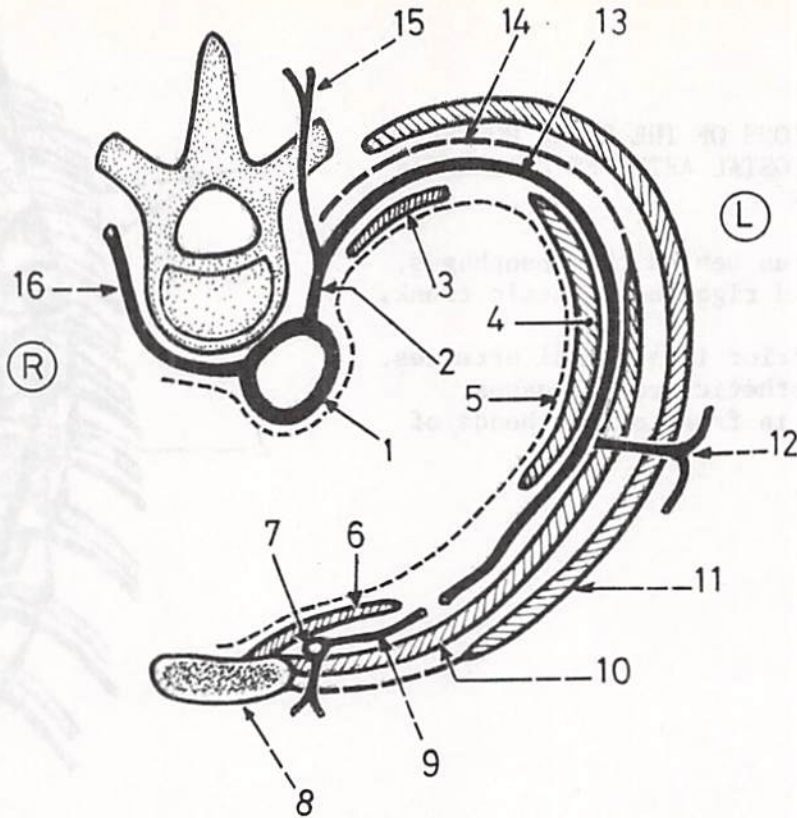


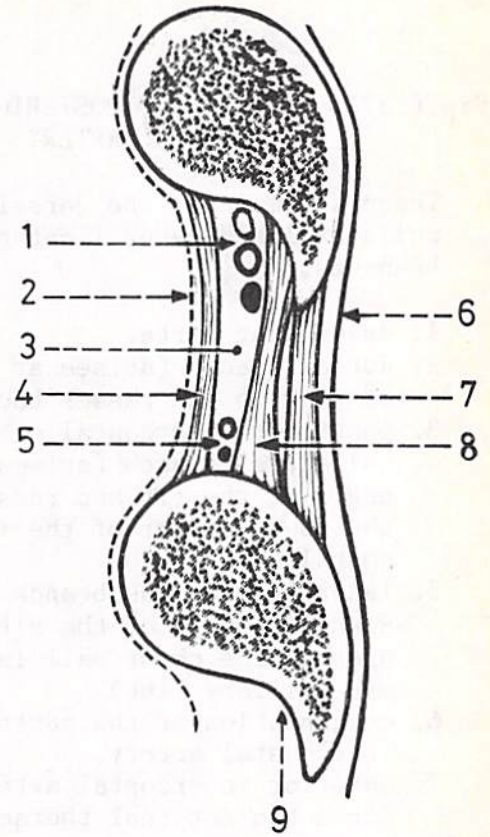
Fig.(163): COURSE AND RELATIONS OF THE POSTERIOR INTERCOSTAL ARTERY IN THE INTERCOSTAL SPACE

In the posterior part of the intercostal space, the artery lies between the subcostalis and parietal pleura (internally) and the posterior intercostal membrane (externally). In the costal groove, the artery lies between the innermost intercostal and parietal pleura (internally) and the internal intercostal (externally). At the costochondral junction, it ends by anastomosing with the anterior intercostal artery.

1. descending aorta (T.S.).
2. left posterior intercostal artery.
3. subcostalis muscle (in front of the artery).
4. innermost intercostal muscle (deep to the artery).
5. parietal pleura.
6. sternocostalis muscle (behind the internal thoracic artery).
7. internal thoracic artery.
8. sternum.
9. anterior intercostal artery (from internal thoracic artery).
10. internal intercostal muscle.
11. external intercostal muscle.
12. lateral cutaneous branch of the posterior intercostal artery.
13. posterior intercostal artery where it enters the costal groove.
14. posterior intercostal membrane.
15. dorsal branch of the posterior intercostal artery.
16. right posterior intercostal artery.

Fig.(164): THE POSTERIOR INTERCOSTAL ARTERY
IN THE INTERCOSTAL SPACE

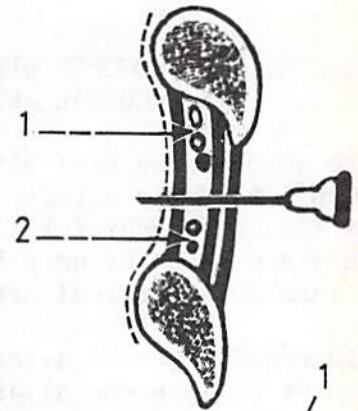
In the intercostal space, the posterior intercostal artery runs in the costal groove in company with its vein (above) and the intercostal nerve (below). This neurovascular bundle is related internally to the innermost intercostal and externally to the internal intercostal.



1. neurovascular bundle (vein, artery and nerve from above downwards).
2. parietal pleura.
3. neurovascular plane.
4. innermost intercostal muscle.
5. collateral branches of the artery and nerve.
6. overlying skin.
7. external intercostal muscle.
8. internal intercostal muscle.
9. costal groove.

Fig.(165): PARACENTESIS THORACIS

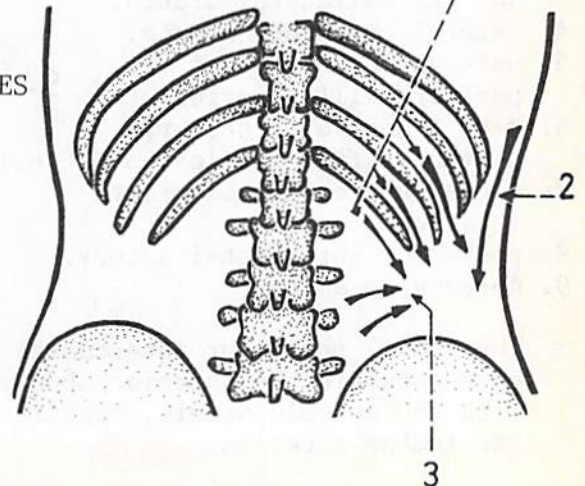
It is the procedure of performing a surgical puncture of the thoracic wall. It should be made midway between the upper and lower boundaries of the intercostal space, to avoid injury of the vessels and nerves which run along the upper and lower borders of the space.



1. posterior intercostal vessels and nerve.
2. collateral branches of the artery and nerve.

Fig.(166): TERMINATIONS OF THE LAST 2 POSTERIOR
INTERCOSTAL AND THE SUBCOSTAL ARTERIES

These 3 arteries pass forwards into the anterior abdominal wall without interruption to anastomose with the lumbar and musculophrenic arteries.



1. lower 2 posterior intercostal and the subcostal arteries.
2. musculophrenic artery.
3. lumbar arteries.

Fig.(167): BRANCHES OF POSTERIOR INTERCOSTAL ARTERY

These are mainly: the dorsal, collateral and lateral cutaneous branches.

1. descending aorta.
2. dorsal branch (arises at the neck of the rib and passes backwards).
3. posterior intercostal artery.
4. collateral branch (arises near the angle of the rib and runs along the lower border of the intercostal space).
5. lateral cutaneous branch (arises near the angle of the rib and pierces the chest wall in the mid-axillary line).
6. continuation of the posterior intercostal artery.
7. anterior intercostal arteries (from the internal thoracic).
8. internal thoracic artery.

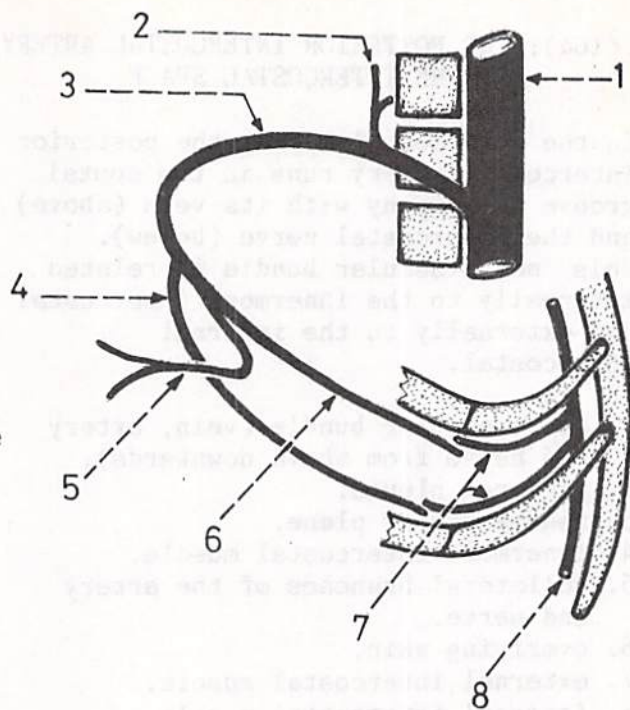
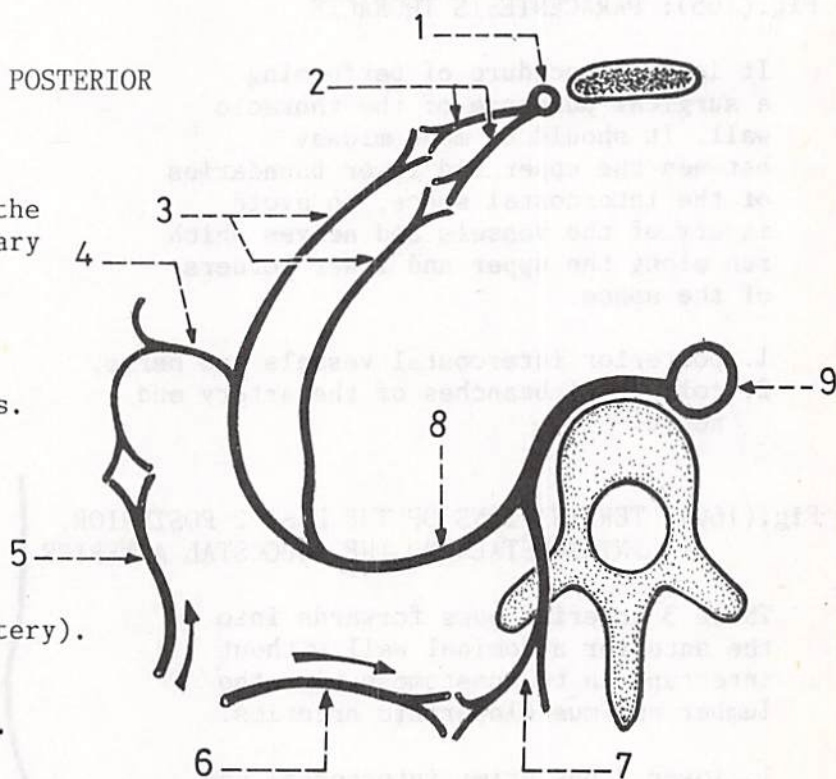


Fig.(168): ANASTOMOSES WITH THE POSTERIOR INTERCOSTAL ARTERIES

These anastomoses are: with the internal thoracic artery, with the subscapular branch of the axillary artery and with the deep branch of transverse cervical artery.

1. internal thoracic artery.
2. anterior intercostal arteries.
3. posterior intercostal artery and its collateral branch.
4. lateral cutaneous branch.
5. subscapular branch of 3rd part of axillary artery.
6. deep branch of transverse cervical (from subclavian artery).
7. dorsal branch of posterior intercostal artery.
8. posterior intercostal artery.
9. descending aorta.



* The last 2 posterior intercostal arteries anastomose in the anterior abdominal wall with the musculophrenic, superior epigastric and lumbar arteries.

Fig.(169): SITES OF ANASTOMOSES WITH THE POSTERIOR INTERCOSTAL ARTERIES

- (a) Anastomosis with the internal thoracic artery and its musculo-phrenic branch in the anterior part of the thoracic wall.
- (b) Anastomosis with the arteries around the scapula (e.g. subscapular artery) on the side of the chest.
- (c) Anastomosis with the arteries around the scapula (e.g. deep branch of transverse cervical artery) on the back of the chest.
- (d) Anastomosis with the musculo-phrenic, superior epigastric and lumbar arteries in the anterior abdominal wall.

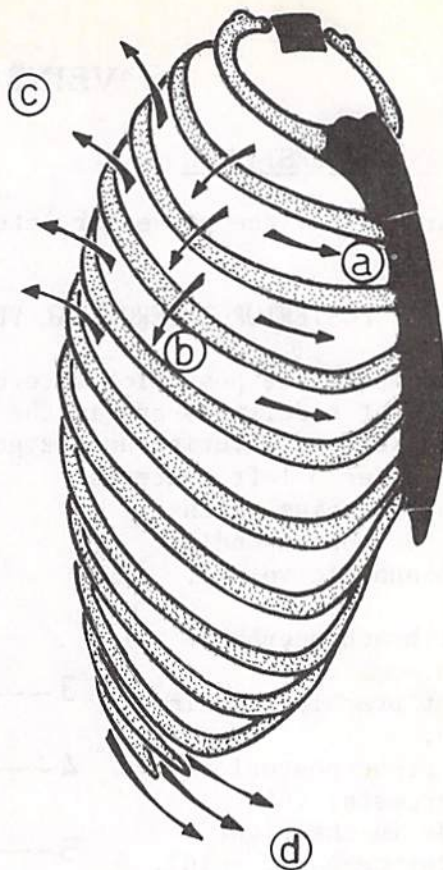
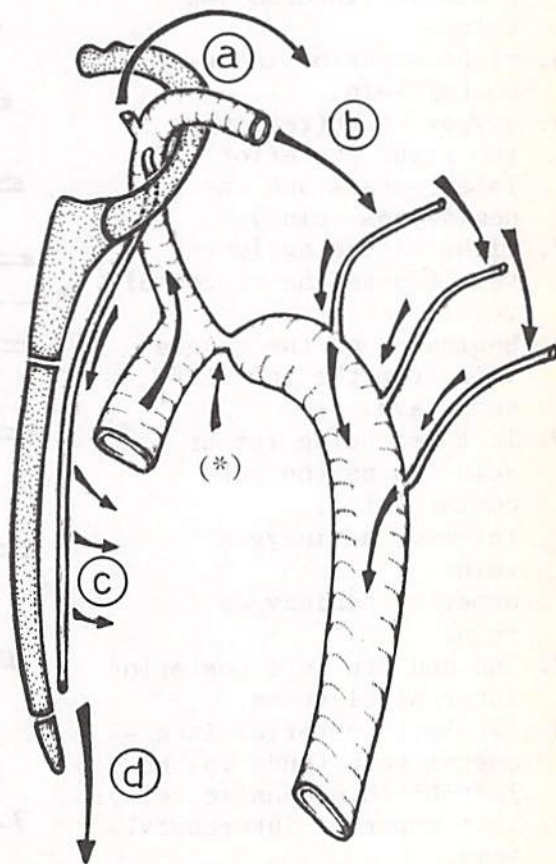


Fig.(170): COARCTATION OF THE AORTA

This is the condition where the arch of the aorta is stenosed (*) (narrowed) just below the origin of the left subclavian artery. In this case, collateral circulation is established through the following anastomoses:

- (a) Between the deep branch of transverse cervical artery (from the thyrocervical trunk of subclavian artery) and the posterior intercostal arteries.
- (b) Between the subscapular artery (from 3rd part of axillary artery) and the posterior intercostal arteries.
- (c) Between the anterior intercostal arteries (from the internal thoracic artery) and the posterior intercostal arteries.
- (d) Between the superior epigastric artery (from internal thoracic) and inferior epigastric (from external iliac).



* The stenosis is marked by (*)

VEINS OF THE CHEST

VEINS OF THE CHEST WALL

These are mainly the posterior intercostals, azygos, hemiazygos and internal thoracic.

Fig.(171): POSTERIOR INTERCOSTAL VEINS

They accompany the posterior intercostal arteries and end differently on both sides. On the right side, they end in the azygos vein, while on the left side they end in the superior and inferior hemiazygos veins (except the 1st right posterior intercostal and the upper 3 left posterior intercostal veins which end in the corresponding brachiocephalic veins).

1. left brachiocephalic vein.
2. right brachiocephalic vein.
3. 1st right posterior intercostal vein (ends in the right brachiocephalic vein).
4. 2nd and 3rd right posterior intercostal veins.
5. right superior intercostal vein.
6. azygos vein (receives the right posterior intercostals and the 2 hemiazygos veins).
7. right ascending lumbar vein (joins the subcostal vein).
8. beginning of the azygos vein from the inferior vena cava.
9. left ascending lumbar vein (joins the subcostal vein).
10. inferior hemiazygos vein.
11. superior hemiazygos vein.
12. 2nd and 3rd left posterior intercostal veins.
13. 1st left posterior intercostal vein (ends in the left brachiocephalic vein).
14. left superior intercostal vein.
15. superior vena cava.

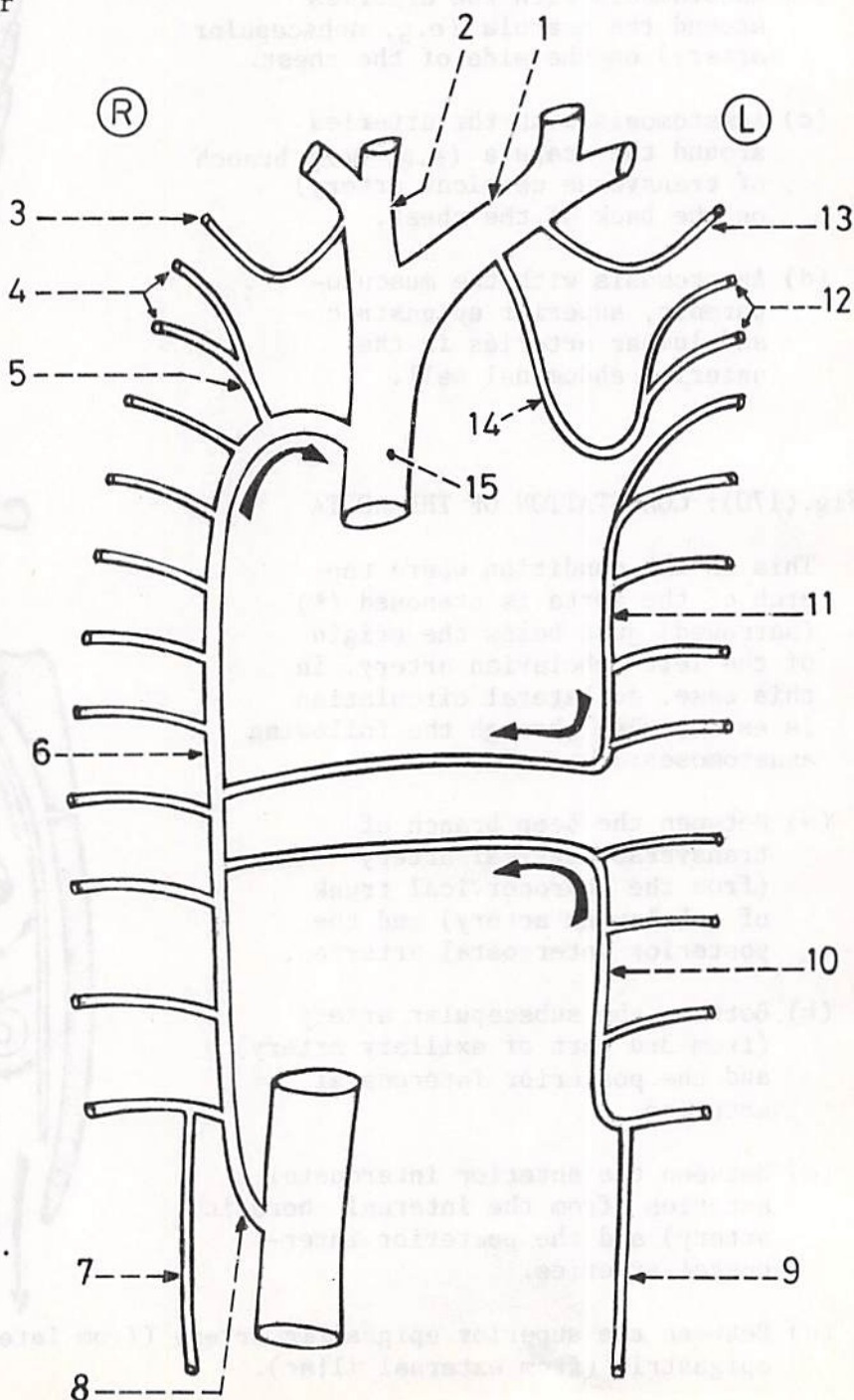


Fig.(172): SUBCOSTAL VEINS

The subcostal vein joins the ascending lumbar vein on each side to form a trunk. This trunk joins the azygos vein on the right side and forms the inferior hemiazygos vein on the left side.

1. azygos vein.
2. right subcostal vein.
3. right ascending lumbar vein.
4. inferior hemiazygos vein.
5. left subcostal vein.
6. left ascending lumbar vein.
7. beginning of azygos vein (from inferior vena cava).

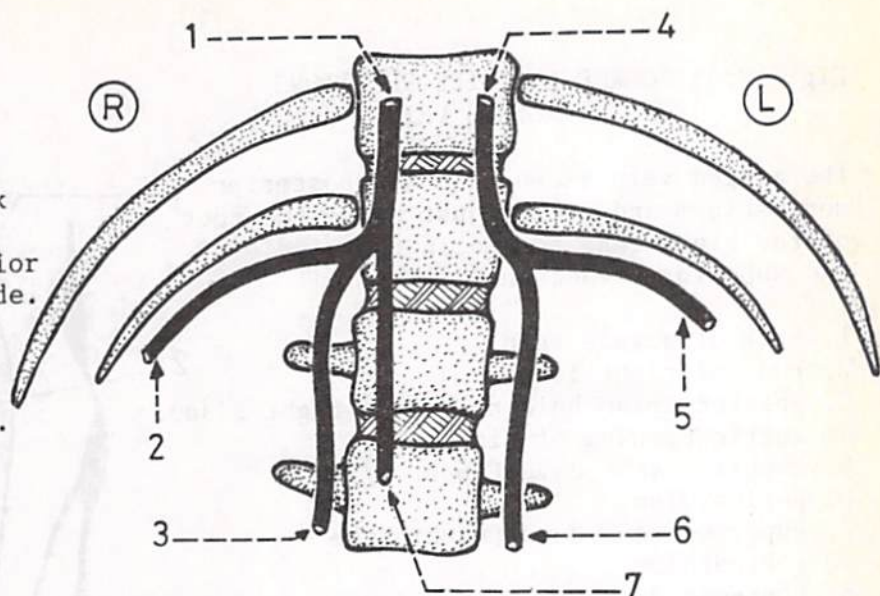


Fig.(173): ORIGIN OF AZYGOS VEIN

It arises from the back of the inferior vena cava, but sometimes it is formed by the union of the right subcostal and right ascending lumbar veins.

1. azygos vein.
2. margin of the aortic opening of the diaphragm.
3. inferior vena cava (in the abdomen).

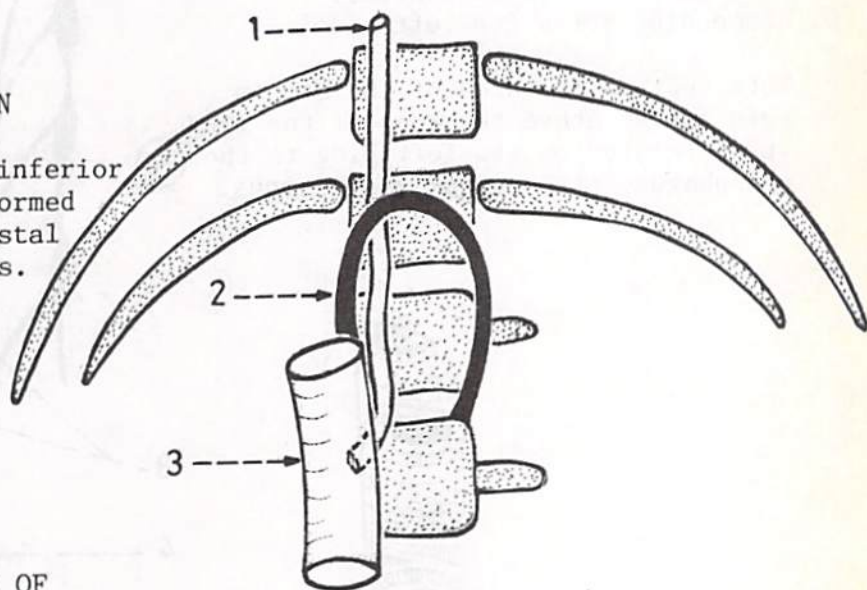


Fig.(174): PATTERNS OF ENTRANCE OF THE AZYGOS VEIN INTO THE CHEST

- (a) through the aortic opening of the diaphragm.
- (b) through the right crus of the diaphragm.
- (c) behind the right crus of the diaphragm.

1. aortic opening of the diaphragm.
2. left crus of diaphragm.
3. right crus of diaphragm.

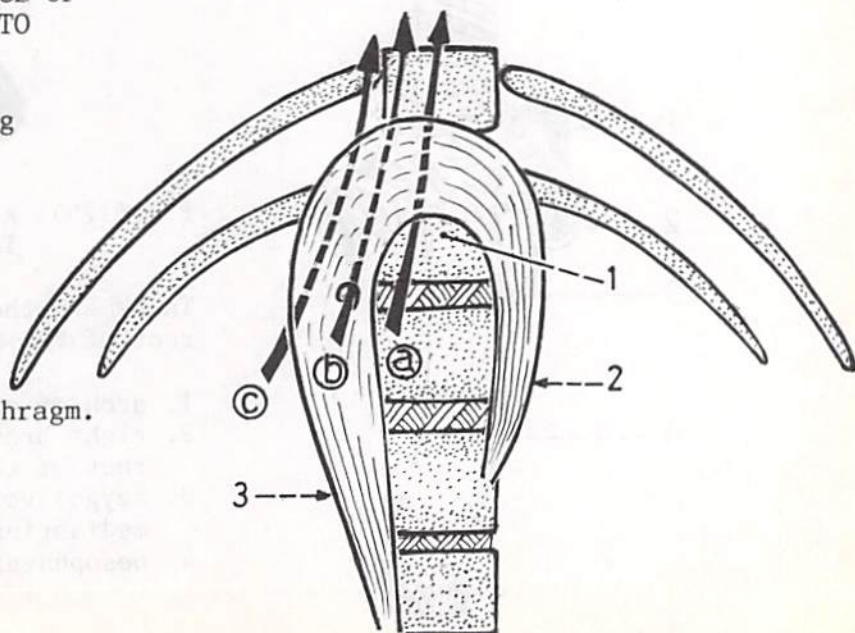


Fig.(175): COURSE AND SIDE RELATIONS
OF THE AZYGOS VEIN

The azygos vein ascends in the posterior mediastinum and arches just above the root of the right lung to end in the middle of the superior vena cava.

1. arch of azygos vein.
2. root of right lung.
3. greater splanchnic nerve (on right side).
4. aortic opening of diaphragm.
5. superior vena cava (upper 1/2).
6. pericardium.
7. superior vena cava (within the pericardium).
8. thoracic duct (on left side).
9. descending aorta (on left side).

* Note that as the arch of the azygos vein curves above the root of the lung it is related on its left side to the oesophagus, trachea and right vagus. (R)

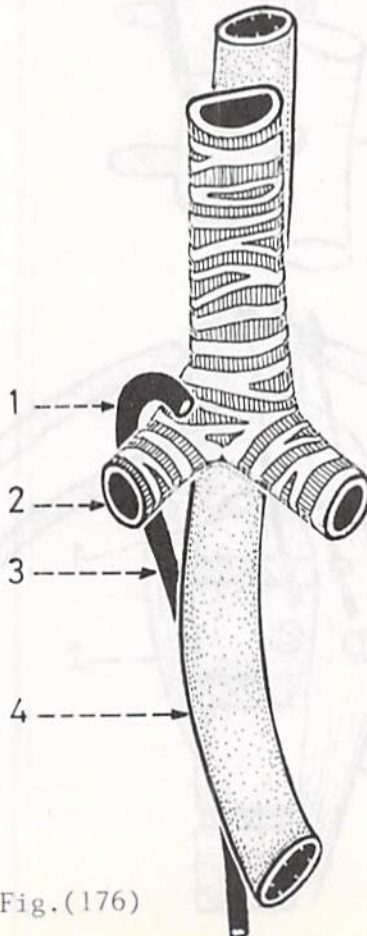
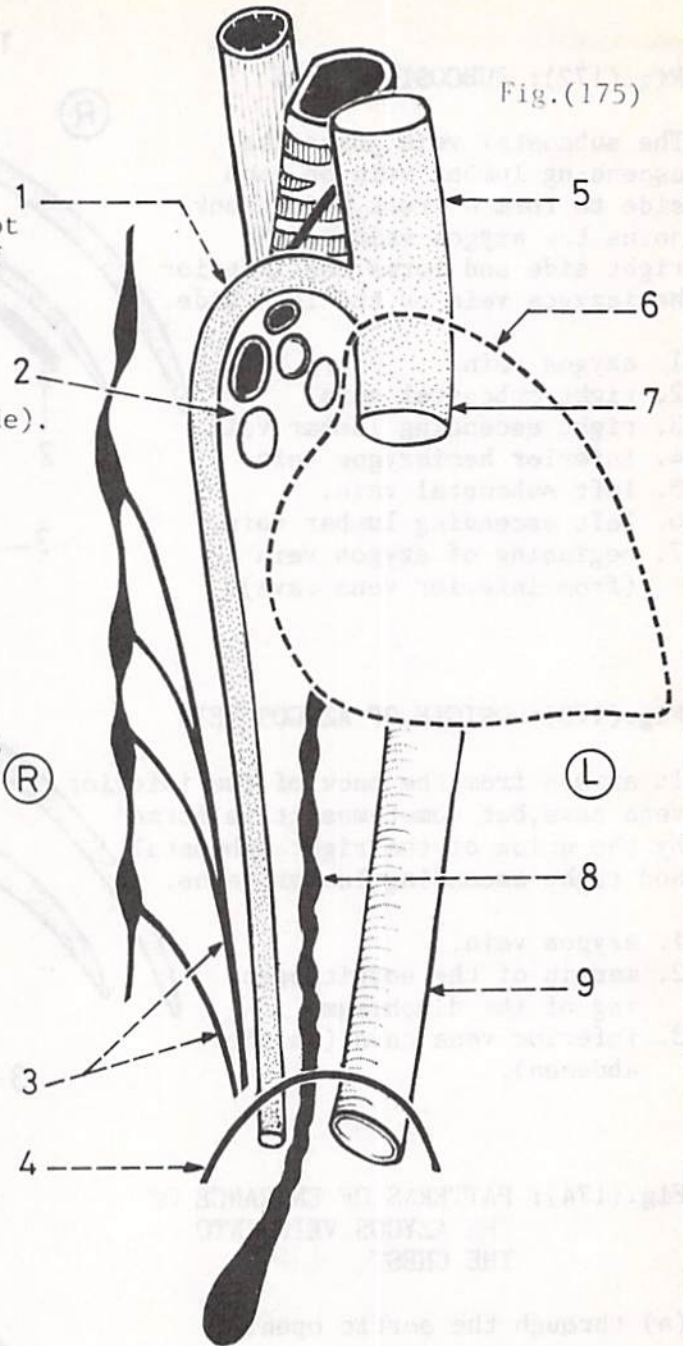


Fig.(176): ANTERIOR RELATIONS OF
THE AZYGOS VEIN

These are the oesophagus and the root of the right lung.

1. arch of azygos vein.
2. right bronchus (representing the root of the lung).
3. azygos vein in the posterior mediastinum.
4. oesophagus.

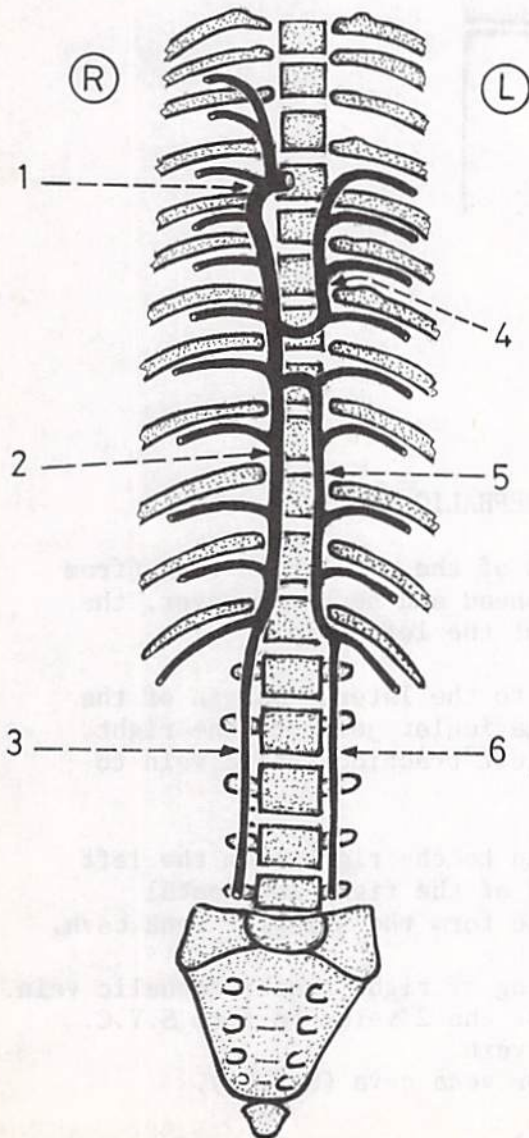
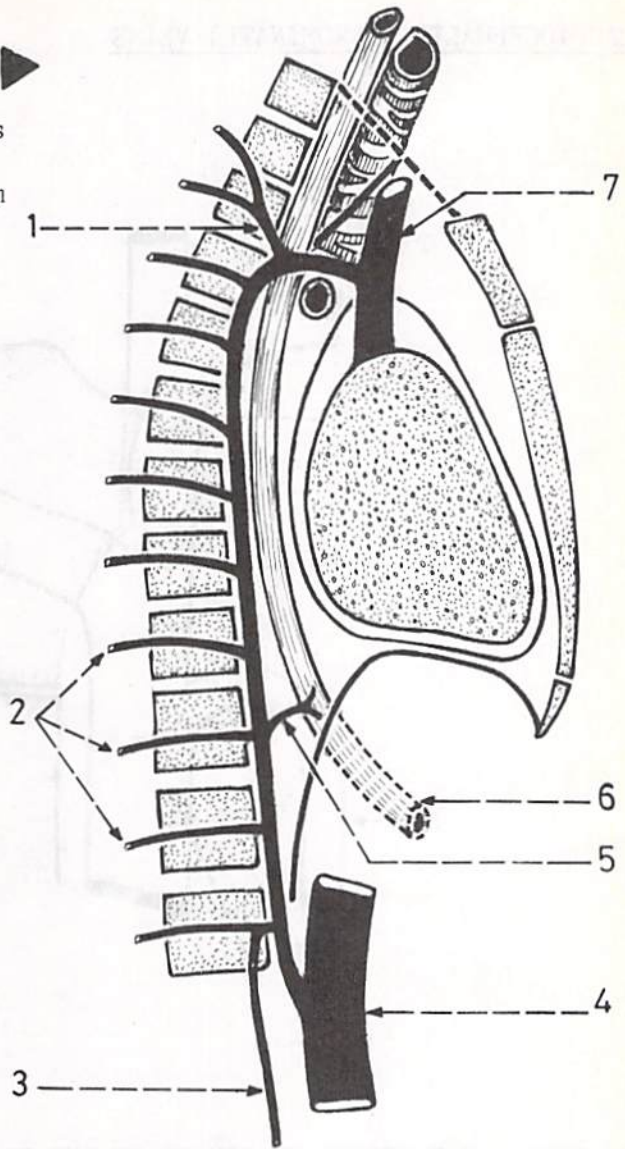
Fig.(176)

Fig.(177): TRIBUTARIES OF THE AZYGOS VEIN ►

These are all right posterior intercostals (except the 1st), the 2 hemiazygos veins and veins from the oesophagus, pericardium and mediastinum.

1. right superior intercostal vein (joins the arch of the azygos vein).
2. right posterior intercostal veins.
3. right ascending lumbar vein.
4. inferior vena cava.
5. vein from the oesophagus.
6. oesophagus.
7. superior vena cava.

* Note that the azygos vein drains most of the chest wall on both sides.



◀ Fig.(178): HEMIAZYGOS VEINS

These are the superior and inferior hemiazygos veins which drain most of the left posterior intercostal veins. They cross the midline to join the azygos vein.

1. arch of azygos vein.
2. azygos vein.
3. right ascending lumbar vein.
4. superior hemiazygos vein (also called accessory hemiazygos).
5. inferior hemiazygos vein (also called hemiazygos).
6. left ascending lumbar vein (joins the subcostal to form the inferior hemiazygos).

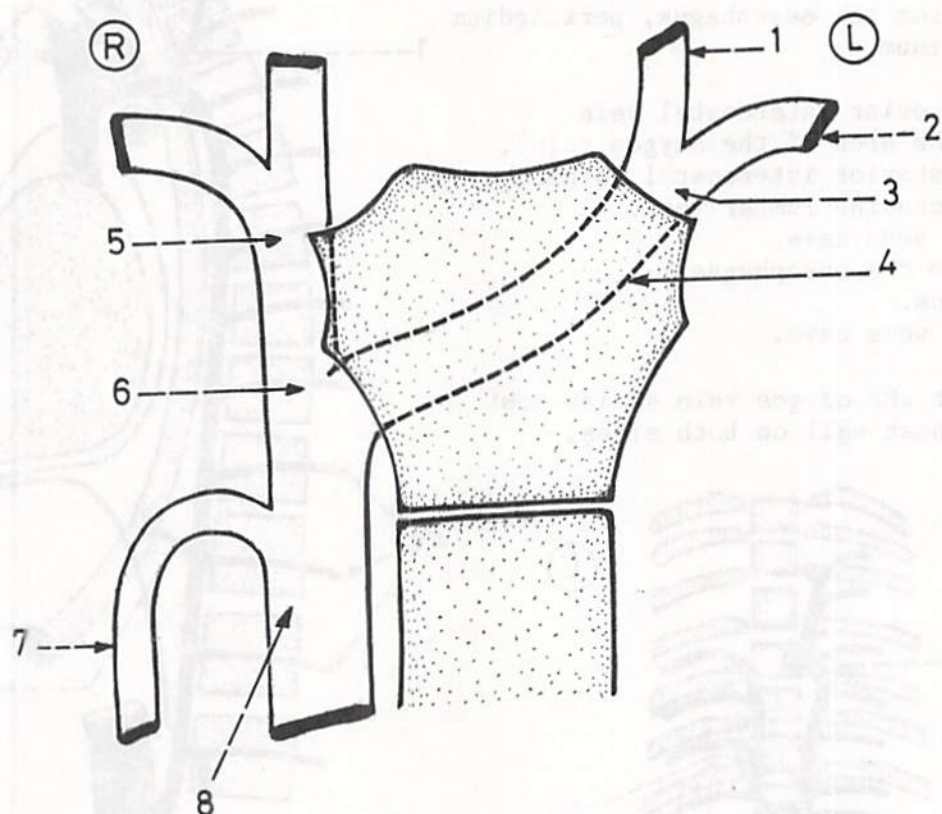
BRACHIOCEPHALIC (INNOMINATE) VEINS

Fig.(179): FORMATION AND COURSE OF THE BRACHIOCEPHALIC VEINS

Each brachiocephalic vein is formed by union of the subclavian vein (from upper limb) and internal jugular vein (from head and neck). However, the course of the right vein differs from that of the left vein.

- * The right vein descends vertically close to the lateral margin of the manubrium sterni, from the right sternoclavicular joint to the right 1st costal cartilage where it joins the left brachiocephalic vein to form the superior vena cava (S.V.C.).
- * The left vein runs obliquely downwards and to the right from the left sternoclavicular joint to the sternal end of the right 1st costal cartilage where it joins the right vein to form the superior vena cava.

- | | |
|--|---|
| 1. left internal jugular vein. | 5. beginning of right brachiocephalic vein. |
| 2. left subclavian vein. | 6. union of the 2 veins to form S.V.C. |
| 3. beginning of left brachiocephalic vein. | 7. azygos vein. |
| 4. left brachiocephalic vein (behind the upper 1/2 of manubrium sterni). | 8. superior vena cava (S.V.C.). |

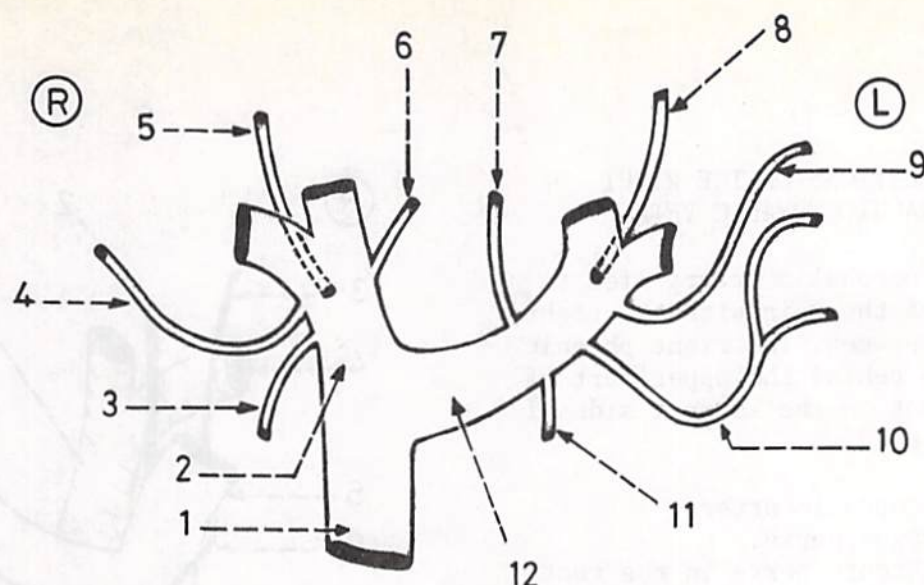


Fig.(180): TRIBUTARIES OF RIGHT AND LEFT BRACHIOCEPHALIC VEINS.

- | | |
|--|---|
| 1. superior vena cava. | 7. left inferior thyroid vein. |
| 2. right brachiocephalic vein. | 8. left vertebral vein. |
| 3. right internal thoracic vein. | 9. left 1st posterior intercostal vein. |
| 4. right 1st posterior intercostal vein. | 10. left superior intercostal vein. |
| 5. right vertebral vein. | 11. left internal thoracic vein. |
| 6. right inferior thyroid vein. | 12. left brachiocephalic vein. |

* Each vein receives: 1st posterior intercostal, internal thoracic, vertebral and inferior thyroid veins. The left brachiocephalic vein receives in addition the left superior intercostal vein.

Fig.(181): SURFACE ANATOMY OF BRACHIOCEPHALIC VEINS AND SUPERIOR VENA CAVA

- * Right brachiocephalic vein: is represented by a vertical line (1) from the right sterno-clavicular joint to the lower border of right 1st costal cartilage, close to the margin of the manubrium sterni (1 inch long).
- * Left brachiocephalic vein: is represented by an oblique line (3) from the left sterno-clavicular joint to the lower border of the right 1st costal cartilage, close to its junction with the sternum (2 inches long).
- * Superior vena cava: is represented by a vertical line (2) drawn close to the right margin of the sternum from the lower border of the 1st costal cartilage to the lower border of the 3rd costal cartilage. (It corresponds to the upper right 2 intercostal spaces.)

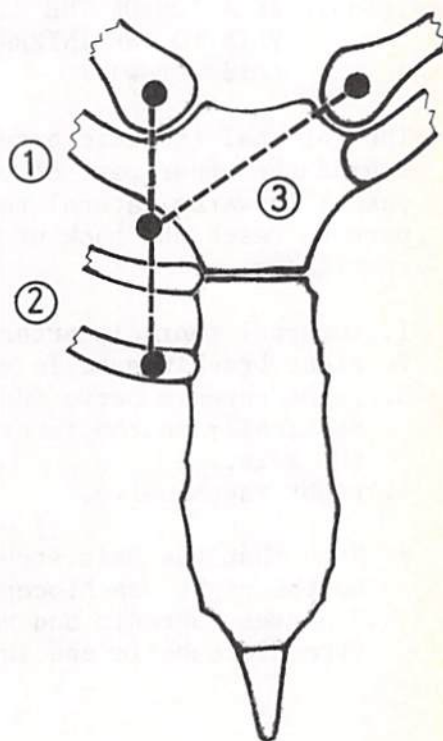


Fig.(182): RELATIONS OF THE RIGHT BRACHIOCEPHALIC VEIN

The brachiocephalic artery lies to the left of the vein with the right vagus in between. The right phrenic nerve lies behind the upper part of the vein but on the lateral side of its lower part.

1. brachiocephalic artery.
2. right vagus nerve.
3. right phrenic nerve in the root of the neck.
4. right subclavian artery.
5. right brachiocephalic vein.
6. right phrenic nerve emerging from behind the vein to come on its lateral side.
7. right vagus nerve behind the superior vena cava.
8. superior vena cava.
9. left brachiocephalic vein.

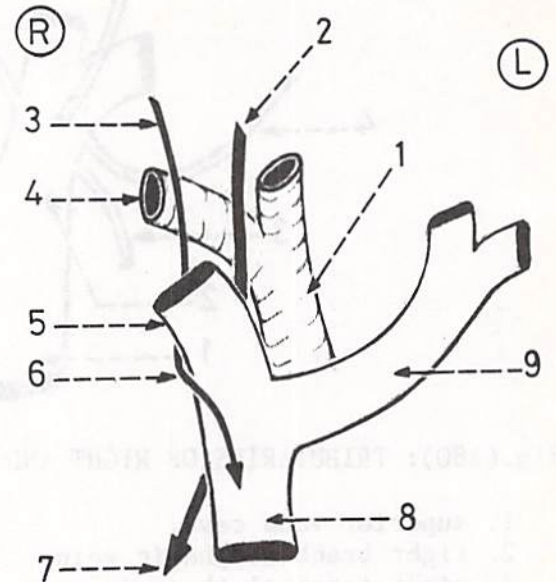
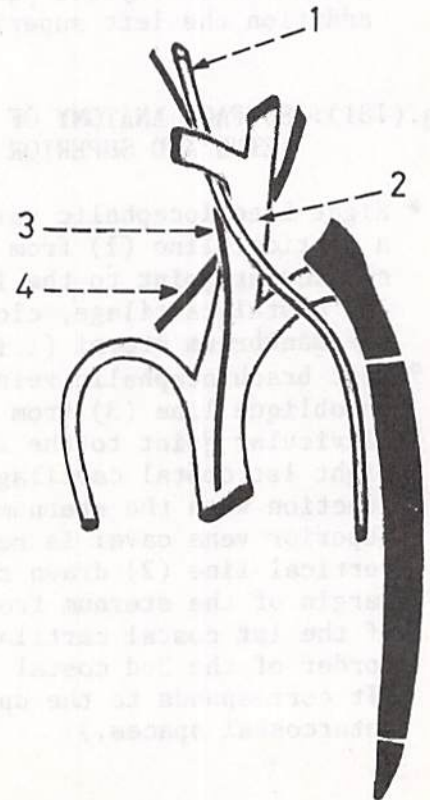


Fig.(183): RELATION OF THE RIGHT BRACHIOCEPHALIC VEIN TO THE INTERNAL THORACIC ARTERY (side view)

The internal thoracic artery descends behind the upper part of the vein, then passes forwards lateral to its lower part to reach the back of the costal cartilages.

1. internal thoracic artery.
2. right brachiocephalic vein.
3. right phrenic nerve (descends vertically on the lateral side of the vein).
4. right vagus nerve.



* Note that the main structures related to the right brachiocephalic vein are: 2 nerves (phrenic and vagus) and 2 arteries (brachiocephalic and internal thoracic).

Fig.(184): RELATIONS OF THE LEFT BRACHIOCEPHALIC VEIN

The vein runs obliquely just above the arch of the aorta in front of the origins of the left subclavian, left common carotid and brachiocephalic arteries, and in front of the left vagus and left phrenic nerves.

1. left brachiocephalic vein.
2. brachiocephalic artery.
3. trachea.
4. left common carotid artery.
5. left vagus nerve.
6. left phrenic nerve.
7. left subclavian artery.

* The vein is the most superficial structure of the superior mediastinum, where it is only separated from the upper 1/2 of manubrium sterni by remains of thymus gland.

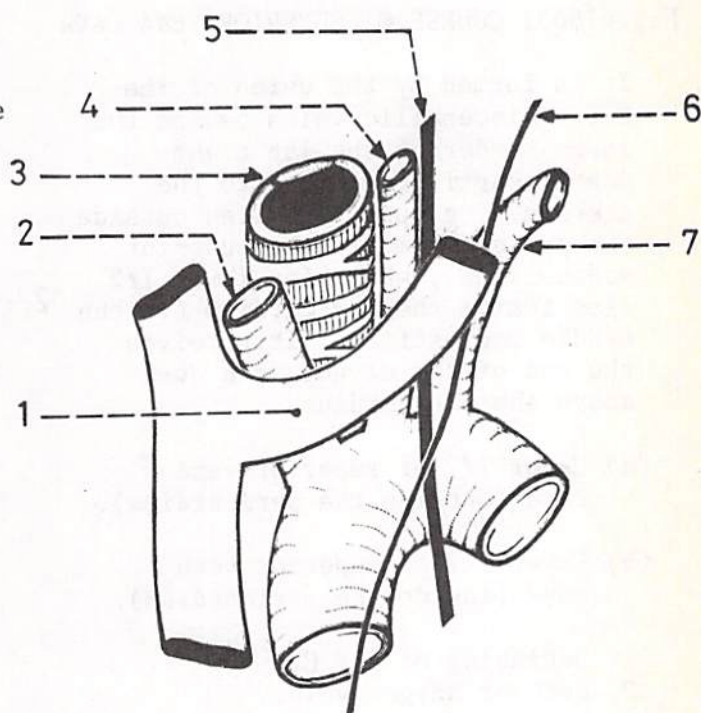
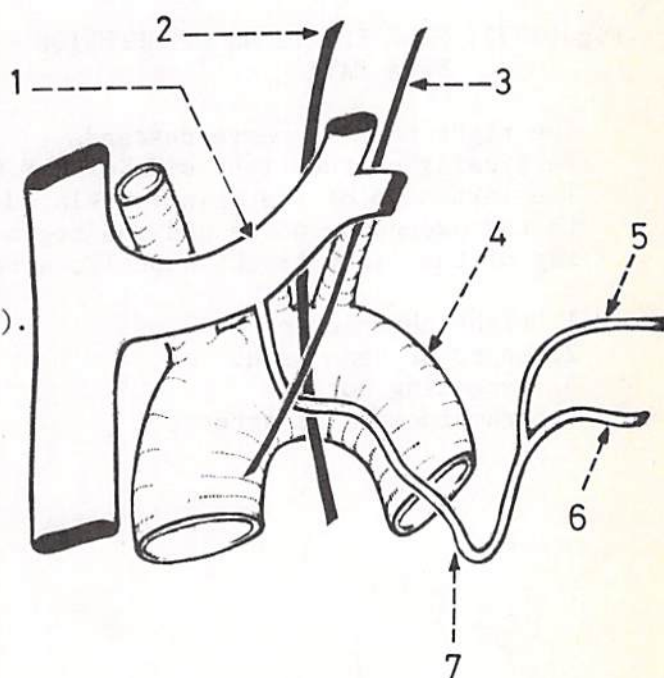


Fig.(185): LEFT SUPERIOR INTERCOSTAL VEIN

It is formed by the union of the 2nd and 3rd left posterior intercostal veins. It runs upwards and forwards on the left side of the aortic arch to end in the left brachiocephalic vein.

1. left brachiocephalic vein.
2. left vagus nerve (descends deep to the left superior intercostal vein).
3. left phrenic nerve (descends superficial to the left superior intercostal vein).
4. arch of the aorta.
5. 2nd left posterior intercostal vein.
6. 3rd left posterior intercostal vein.
7. left superior intercostal vein (runs upwards on the left side of the arch of the aorta between the phrenic and vagus nerves).

* Note that the right superior intercostal vein ends in the arch of the azygos vein.



SUPERIOR VENA CAVA (S.V.C.)

Fig.(186): COURSE OF SUPERIOR VENA CAVA

It is formed by the union of the 2 brachiocephalic veins behind the lower border of the 1st right costal cartilages close to the sternum. Its upper 1/2 lies outside the pericardium (in the superior mediastinum), while its lower 1/2 lies inside the pericardium (in the middle mediastinum). It receives the end of the azygos vein just above the pericardium.

(a) Upper 1/2 of superior vena cava (outside the pericardium).

(b) Lower 1/2 of superior vena cava (inside the pericardium).

1. beginning of S.V.C.
2. arch of azygos vein.
3. lower end of S.V.C.
4. ascending aorta (to the left of S.V.C.).
5. outline of the pericardium.

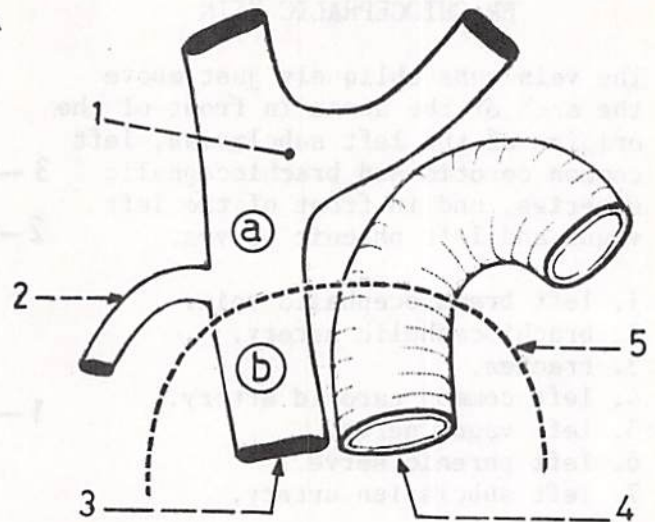


Fig.(187): SIDE RELATIONS OF SUPERIOR VENA CAVA

The right phrenic nerve descends vertically on the right side of S.V.C. The left side of the vein is related to the ascending aorta and the beginning of the right brachiocephalic artery.

1. right phrenic nerve.
2. superior vena cava.
3. ascending aorta.
4. brachiocephalic artery.

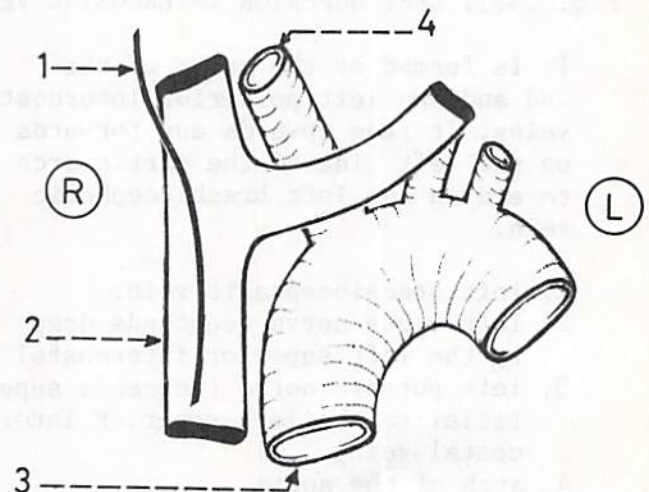


Fig.(188): POSTERIOR RELATIONS OF SUPERIOR VENA CAVA

The S.V.C. is related posteriorly to the root of the right lung and the right vagus nerve.

1. trachea.
2. right vagus nerve descending obliquely on the right side of the trachea.
3. arch of azygos vein.
4. root of right lung (behind the lower part of S.V.C.).
5. superior vena cava.

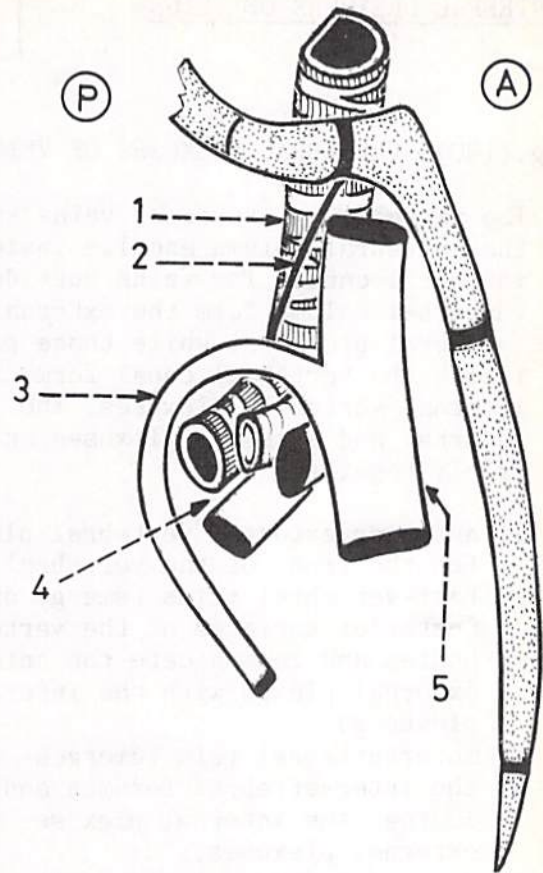
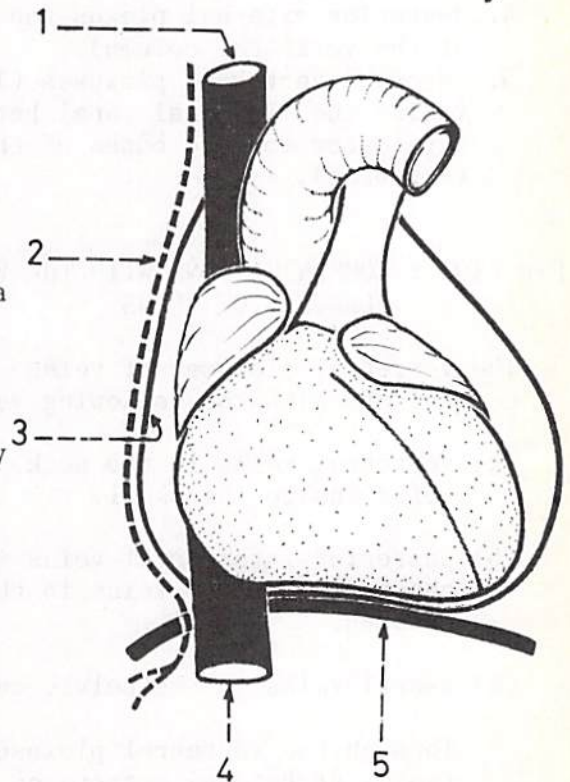


Fig.(189): PARTS OF SUPERIOR VENA CAVA AND INFERIOR VENA CAVA INSIDE THE PERICARDIUM

The superior vena cava has its lower part present inside the pericardial cavity. The inferior vena cava, however, runs most of its course in the abdomen with only a short part inside the chest. The thoracic part of the inferior vena cava runs partly outside and partly inside the pericardial cavity.

1. superior vena cava.
2. right phrenic nerve (descends vertically on the right side of S.V.C., fibrous pericardium overlying the right atrium and right side of the thoracic part of I.V.C., from above downwards).
3. fibrous pericardium.
4. inferior vena cava (I.V.C.).
5. central tendon of diaphragm.



VERTEBRAL PLEXUSES OF VEINS

Fig.(190): VERTEBRAL PLEXUSES OF VEINS

The vertebral plexuses of veins surround the vertebral column and lie inside its vertebral canal. The veins outside the vertebral column form the external vertebral plexuses, while those present inside the vertebral canal form the internal vertebral plexuses. The internal and external plexuses anastomose freely together.

1. anterior external vertebral plexus (on the front of the vertebral column).
2. basi-vertebral veins (emerge on the posterior surfaces of the vertebral bodies and communicate the anterior external plexus with the internal plexuses).
3. intervertebral vein (emerges through the intervertebral foramen and communicates the internal plexuses with the external plexuses).
4. posterior external plexus (on the back of the vertebral column).
5. internal vertebral plexuses (lie inside the vertebral canal between the dura mater and the bones of the vertebrae).

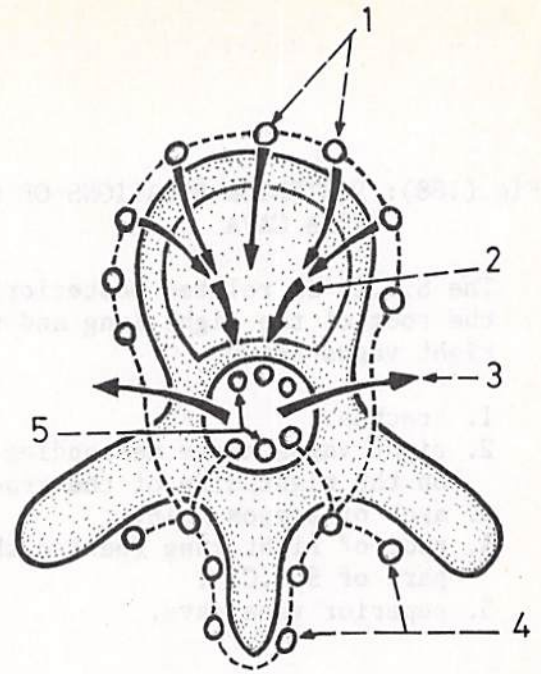
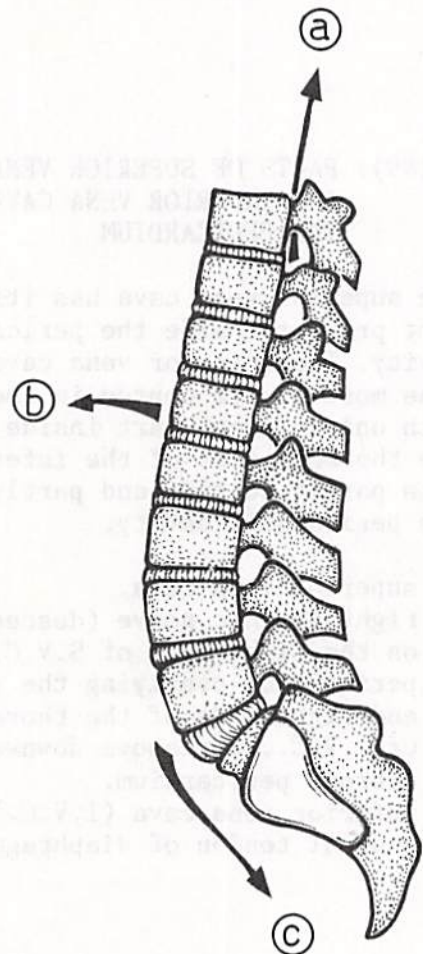


Fig.(191): COMMUNICATIONS WITH THE VERTEBRAL PLEXUSES OF VEINS

The vertebral plexuses of veins communicate with the following veins:

- (a) vertebral veins in the neck, and veins inside the skull.
- (b) posterior intercostal veins in the chest, and lumbar veins in the abdomen.
- (c) sacral veins in the pelvic cavity.

* Through the vertebral plexuses of veins (veins of Batson) metastases can spread from the pelvic cavity to the vertebral column and the brain.



THORACIC INLET

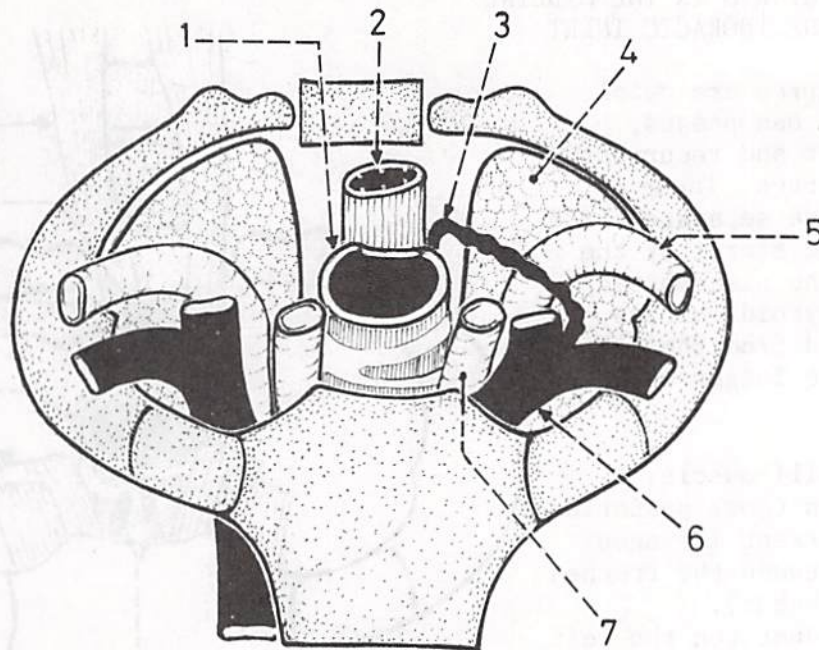


Fig.(192): BOUNDARIES AND CONTENTS OF THE THORACIC INLET

The thoracic inlet is bounded by the 1st thoracic vertebra (behind), the upper border of the manubrium sterni (in front) and the inner border of the 1st rib (on each side). The inlet slopes from behind downwards and forwards. This slope explains why the apex of the lung projects upwards into the root of the neck.

The thoracic inlet transmits structures that pass between the thorax and the neck such as the trachea, oesophagus, blood vessels and nerves.

1. trachea.
2. oesophagus.
3. thoracic duct (on the left side only).
4. apex of the lung (reaches up to the level of the neck of the 1st rib).
5. subclavian artery.
6. left brachiocephalic vein.
7. left common carotid artery.

Fig.(193): STRUCTURES IN THE MIDLINE
OF THE THORACIC INLET

These structures are mainly the trachea, oesophagus, thoracic duct and recurrent laryngeal nerves. These structures are separated from the manubrium sterni by the origins of the sternohyoid and sternothyroid muscles, and separated from the vertebrae behind by the longus colli muscle.

1. longus colli muscle.
2. oesophagus (most posterior).
3. left recurrent laryngeal nerve (between the trachea and oesophagus).
4. thoracic duct (on the left margin of the oesophagus).
5. trachea (most anterior).
6. sternothyroid muscle.
7. sternohyoid muscle.
8. inferior thyroid veins (on the front of the trachea).

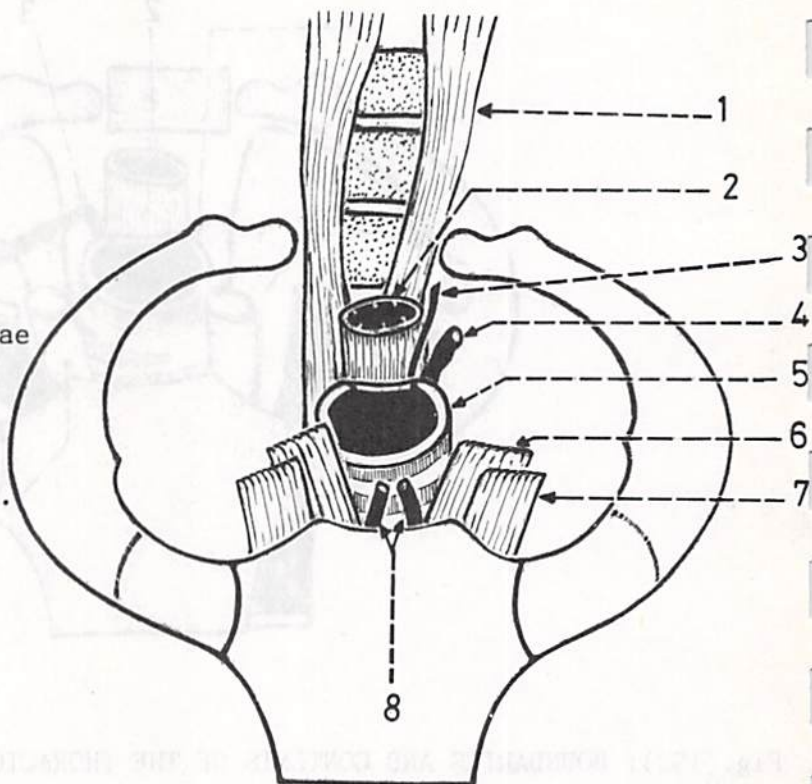


Fig.(194): POSITION OF THE LEFT BRACHIOCEPHALIC
VEIN IN THE CHILD

In the child, the left brachiocephalic vein is situated so high that it crosses the mid-line of the thoracic inlet just above the manubrium sterni (arrow).

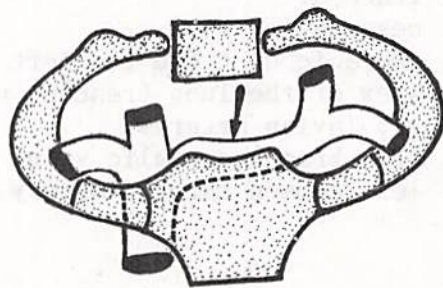


Fig.(195): STRUCTURES ON EACH SIDE OF THE MIDLINE OF THE THORACIC INLET

These are mainly vessels (common carotid and subclavian arteries and brachiocephalic veins) and nerves (vagus and phrenic).

1. right common carotid artery.
2. right vagus nerve.
3. right phrenic nerve.
4. right subclavian artery.
5. right brachiocephalic vein.
6. midline of thoracic inlet.

* In addition to these structures there are the apex of the lung, cervical pleura and supra-pleural membrane, on each side of the midline.

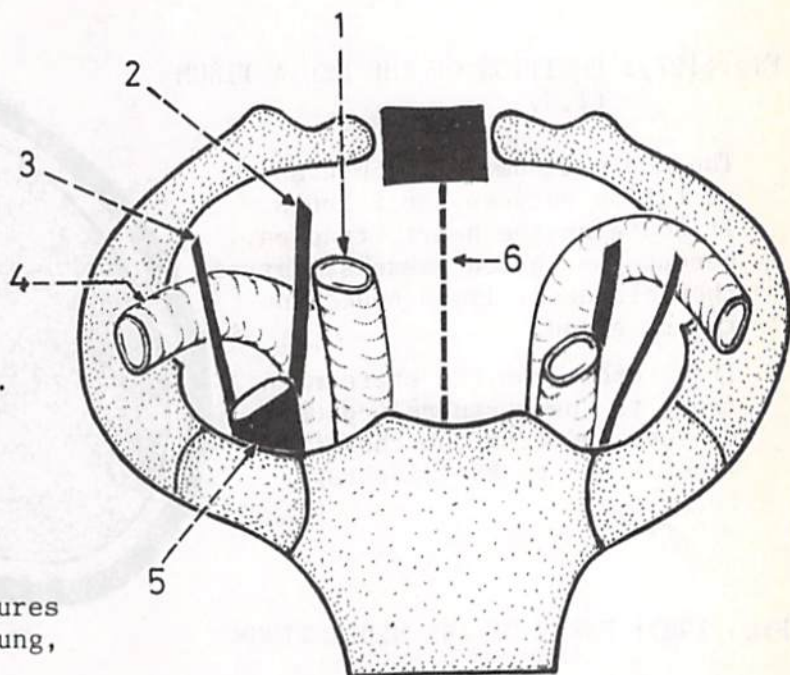
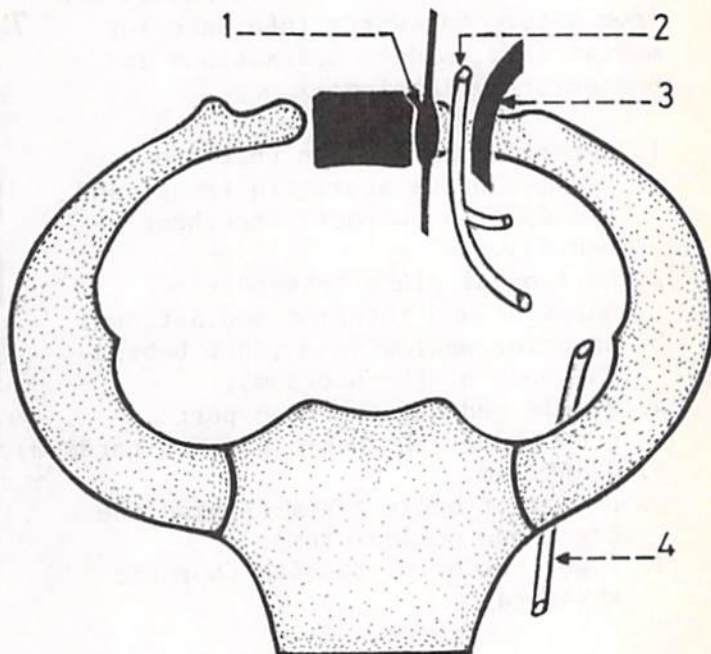


Fig.(196): STRUCTURES IN FRONT OF AND BEHIND THE APEX OF THE LUNG

These structures are the sympathetic trunk, superior intercostal artery and ventral ramus of the 1st thoracic nerve (behind, between the lung and neck of the 1st rib), and the internal thoracic artery (in front, between the lung and the 1st costal cartilage).

1. cervicothoracic ganglion (sympathetic ganglion).
2. superior intercostal artery (between the ganglion and the 1st thoracic nerve).
3. ventral ramus of 1st thoracic nerve (lateral to the artery).
4. internal thoracic artery (just behind the 1st costal cartilage).



MEDIASTINUM

Fig.(197): POSITION OF THE MEDIASTINUM
(T.S.)

The mediastinum is the median partition between the 2 lungs. It contains the heart, trachea, oesophagus, blood vessels, nerves, thoracic duct, lymph nodes and thymus gland.

It extends from the sternum in front to the vertebral column behind, and from the thoracic inlet above to the diaphragm below.

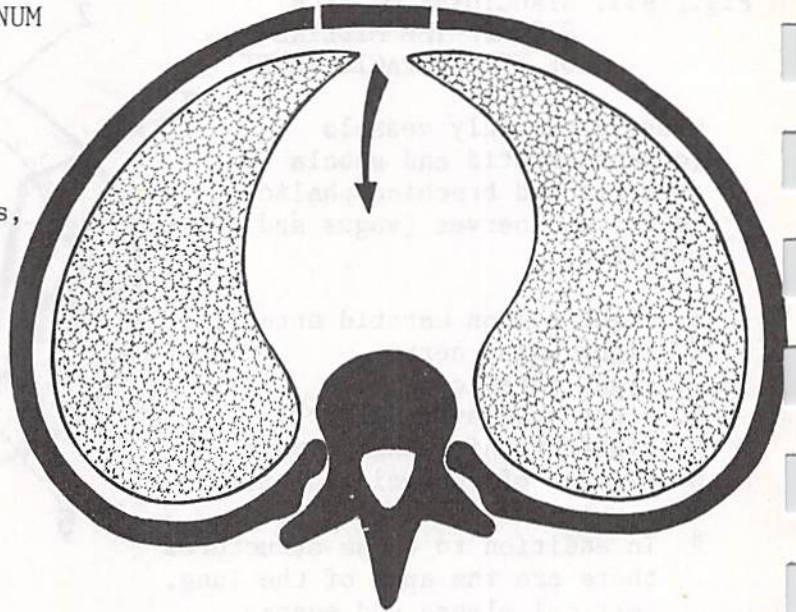
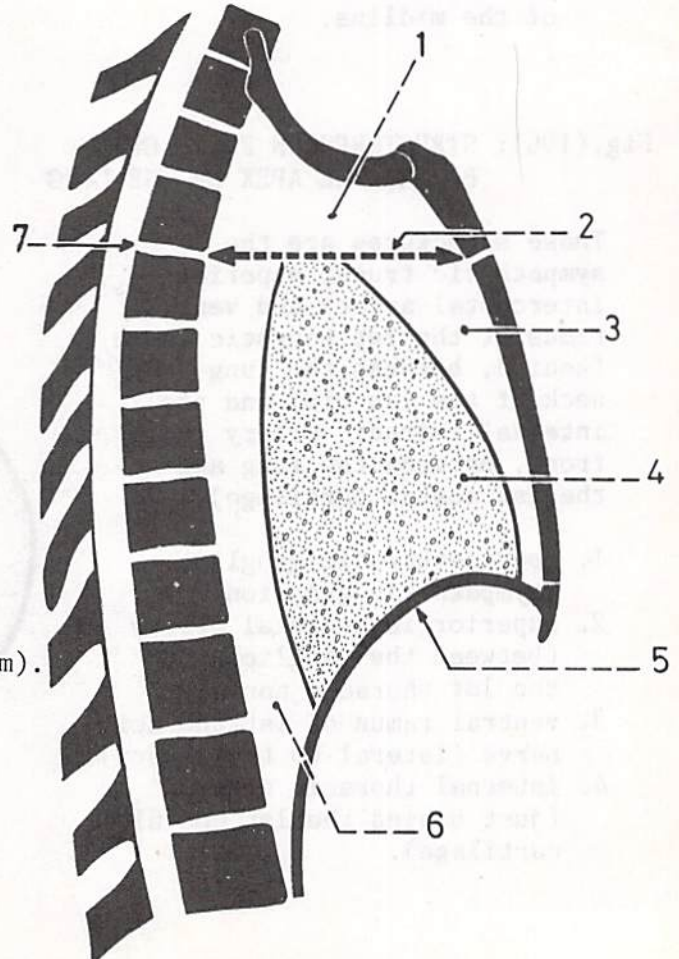


Fig.(198): PARTS OF THE MEDIASTINUM

The mediastinum is divided into an upper part called superior mediastinum and a lower part called inferior mediastinum by the horizontal plane extending from the sternal angle (in front) to the lower border of the 4th thoracic vertebra (behind). The inferior mediastinum is subdivided from before backwards into anterior mediastinum, middle mediastinum and posterior mediastinum.

1. superior mediastinum (between the manubrium sterni in front, and the upper 4 thoracic vertebrae behind).
2. horizontal plane between the superior and inferior mediastinum.
3. anterior mediastinum (just behind the body of the sternum).
4. middle mediastinum (the part occupied by the heart and pericardium).
5. diaphragm.
6. posterior mediastinum (behind the heart and pericardium).
7. lower border of the 4th thoracic vertebra.



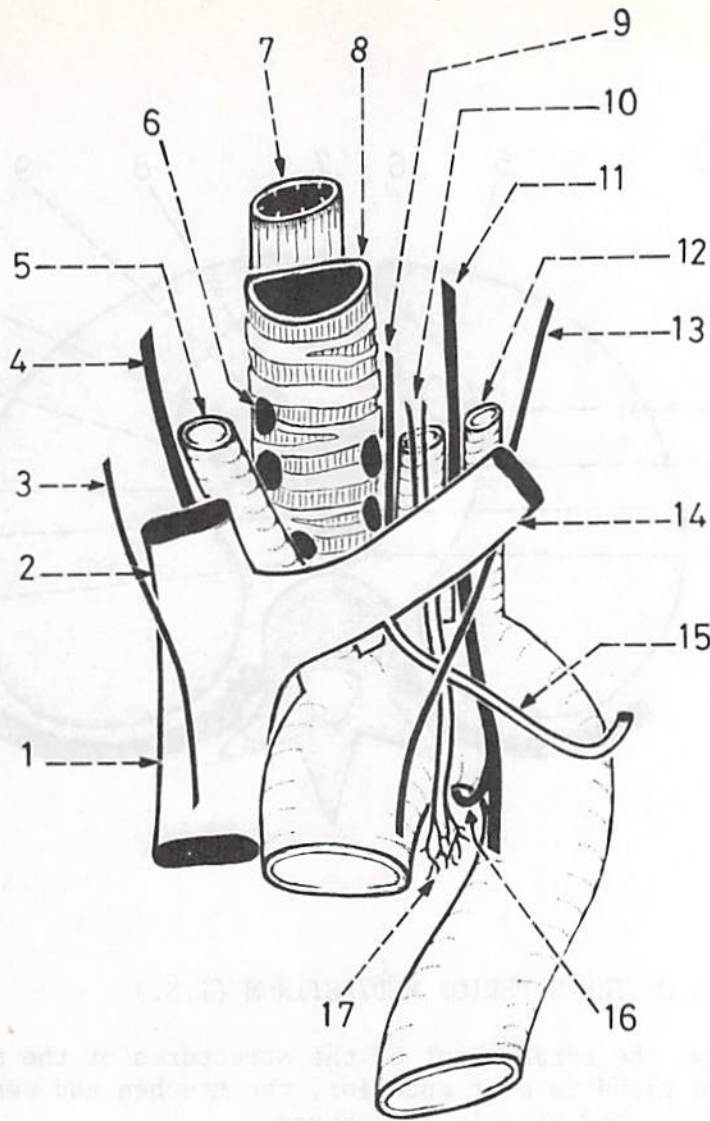


Fig.(199): CONTENTS OF SUPERIOR MEDIASTINUM

The contents of the superior mediastinum are arranged as follows, from before backwards: thymus gland, brachiocephalic veins, arch of the aorta and its 3 branches, trachea and related nerves and lymph nodes, and oesophagus with the related thoracic duct.

- | | |
|------------------------------------|---|
| 1. superior vena cava. | 10. cardiac branches to the superficial cardiac plexus. |
| 2. right brachiocephalic vein. | 11. left vagus nerve. |
| 3. right phrenic nerve. | 12. left subclavian artery. |
| 4. right vagus nerve. | 13. left phrenic nerve. |
| 5. brachiocephalic artery. | 14. left brachiocephalic vein. |
| 6. tracheal lymph nodes. | 15. left superior intercostal vein. |
| 7. oesophagus. | 16. left recurrent laryngeal nerve. |
| 8. trachea. | 17. superficial cardiac plexus. |
| 9. left recurrent laryngeal nerve. | |

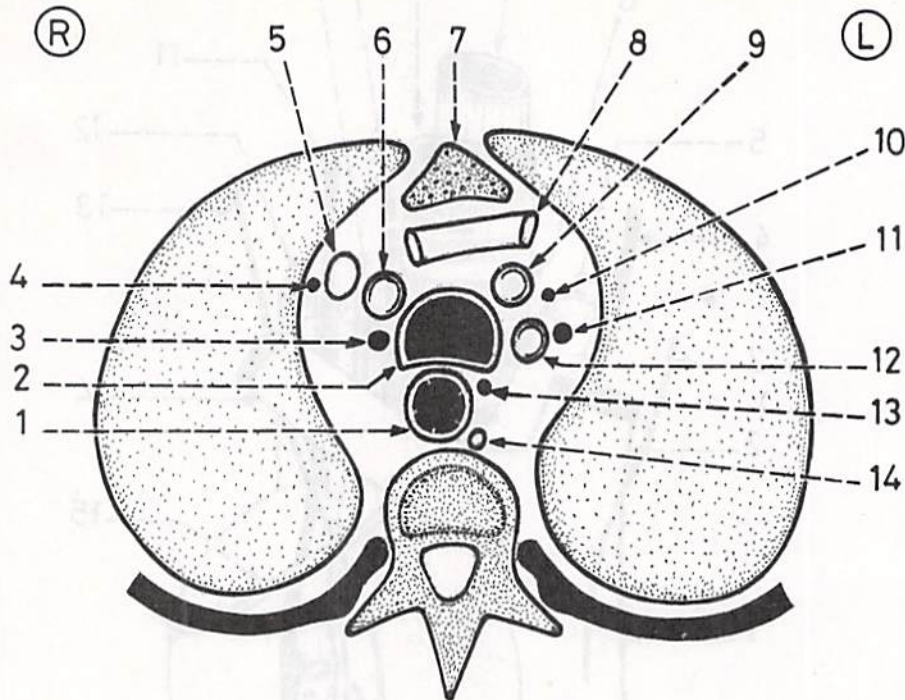


Fig.(200): CONTENTS OF THE SUPERIOR MEDIASTINUM (T.S.)

This figure shows the arrangement of the structures of the superior mediastinum where the thymus gland is most anterior, the trachea and oesophagus most posterior and the blood vessels in between.

1. oesophagus (most posterior).
2. trachea (in front of the oesophagus).
3. right vagus nerve (in direct contact with the side of the trachea).
4. right phrenic nerve (on the right side of the superior vena cava).
5. upper part of superior vena cava.
6. brachiocephalic artery.
7. thymus gland (most anterior).
8. left brachiocephalic vein.
9. left common carotid artery.
10. left phrenic nerve.
11. left vagus nerve (separated from the trachea by the left subclavian artery).
12. left subclavian artery.
13. left recurrent laryngeal nerve (in the groove between the trachea and oesophagus).
14. thoracic duct (on the left side of the oesophagus).

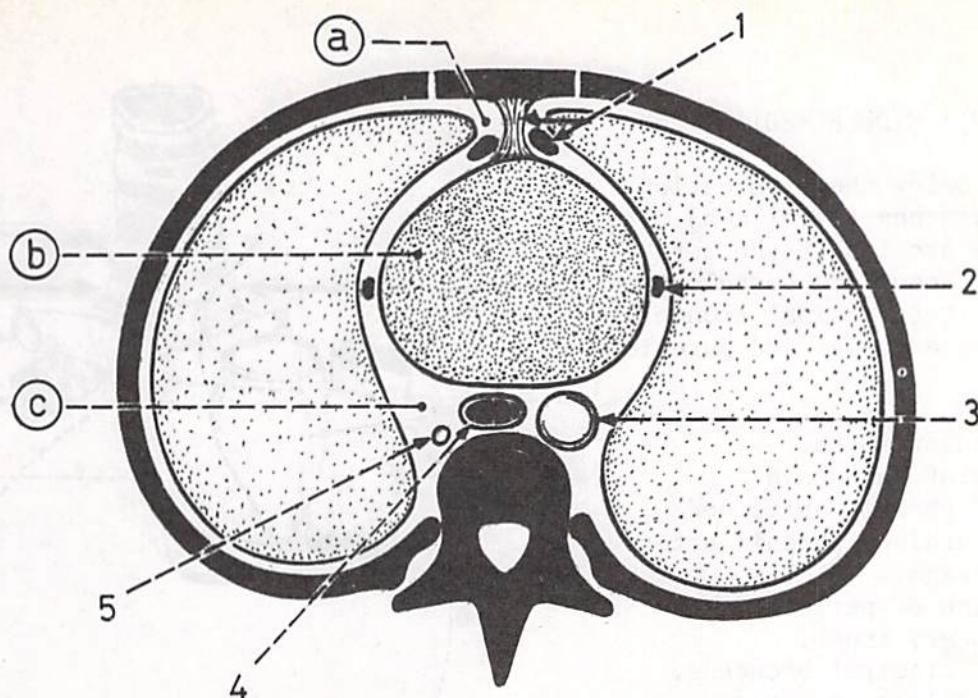


Fig.(201): PARTS OF THE INFERIOR MEDIASTINUM (T.S.)

- (a) Anterior mediastinum (between the sternum and pericardium).
 - (b) Middle mediastinum (occupied by the heart and pericardium).
 - (c) Posterior mediastinum (between the pericardium and the vertebral column).
1. contents of anterior mediastinum (sternopericardial ligaments and few lymph nodes).
 2. left phrenic nerve (on the side of the pericardium).
 3. descending aorta (behind the pericardium).
 4. oesophagus (in the posterior mediastinum).
 5. azygos vein (in the posterior mediastinum).

Fig.(202): THYMUS GLAND

The gland lies in the superior mediastinum directly behind the manubrium sterni. It extends downwards into the anterior mediastinum and upwards, to a variable distance, into the root of the neck (arrow).

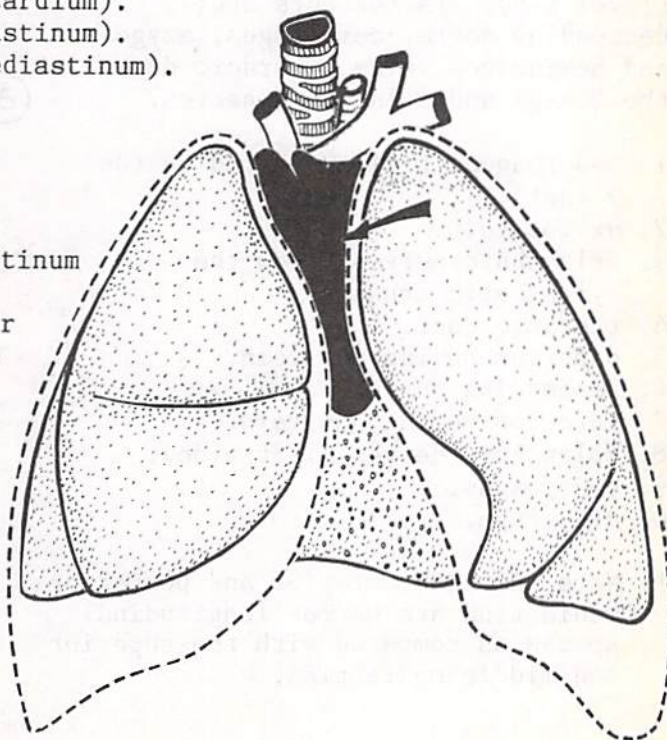


Fig.(203): MIDDLE MEDIASTINUM

It lies below the bifurcation of the trachea (level a-a). Its contents are inside the pericardium (heart and vessels) and outside it (principal bronchi, pulmonary arteries and phrenic nerves).

1. ascending aorta.
2. superior vena cava.
3. right phrenic nerve and pericardiaco-phrenic artery.
4. diaphragm.
5. outline of pericardium.
6. pulmonary trunk.
7. left principal bronchus.
8. left pulmonary artery.
9. nerve to the deep cardiac plexus.

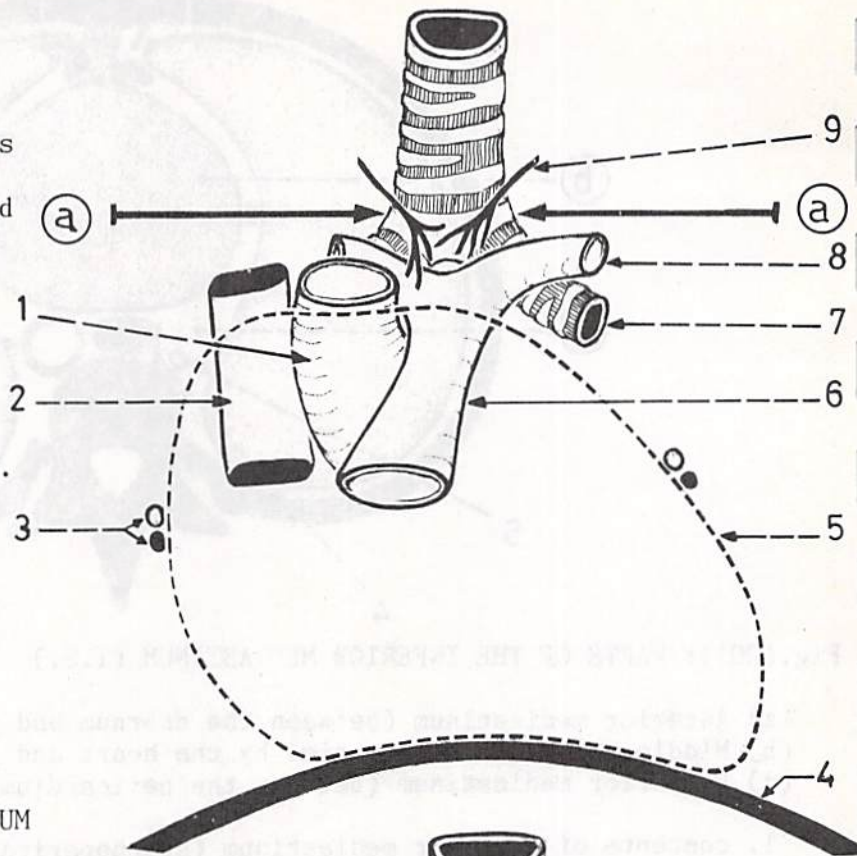
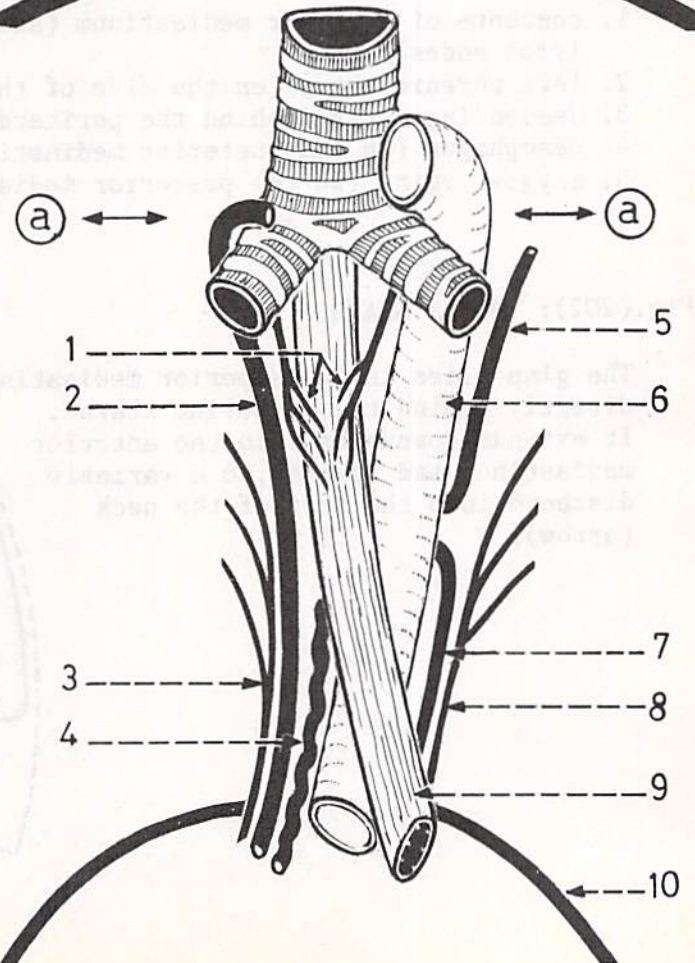


Fig.(204): POSTERIOR MEDIASTINUM

It lies behind the pericardium below the bifurcation of the trachea (level a-a). Its contents are: descending aorta, oesophagus, azygos and hemiazygos veins, thoracic duct, the 2 vagi and splanchnic nerves.

1. oesophageal plexus (formed by the 2 vagi).
2. azygos vein.
3. splanchnic nerves (from the sympathetic trunk).
4. thoracic duct.
5. superior hemiazygos vein.
6. descending aorta.
7. inferior hemiazygos vein.
8. splanchnic nerves (left side).
9. oesophagus.
10. diaphragm.

* Note that the anterior and posterior mediastina are narrow longitudinal spaces as compared with the superior and middle mediastina.



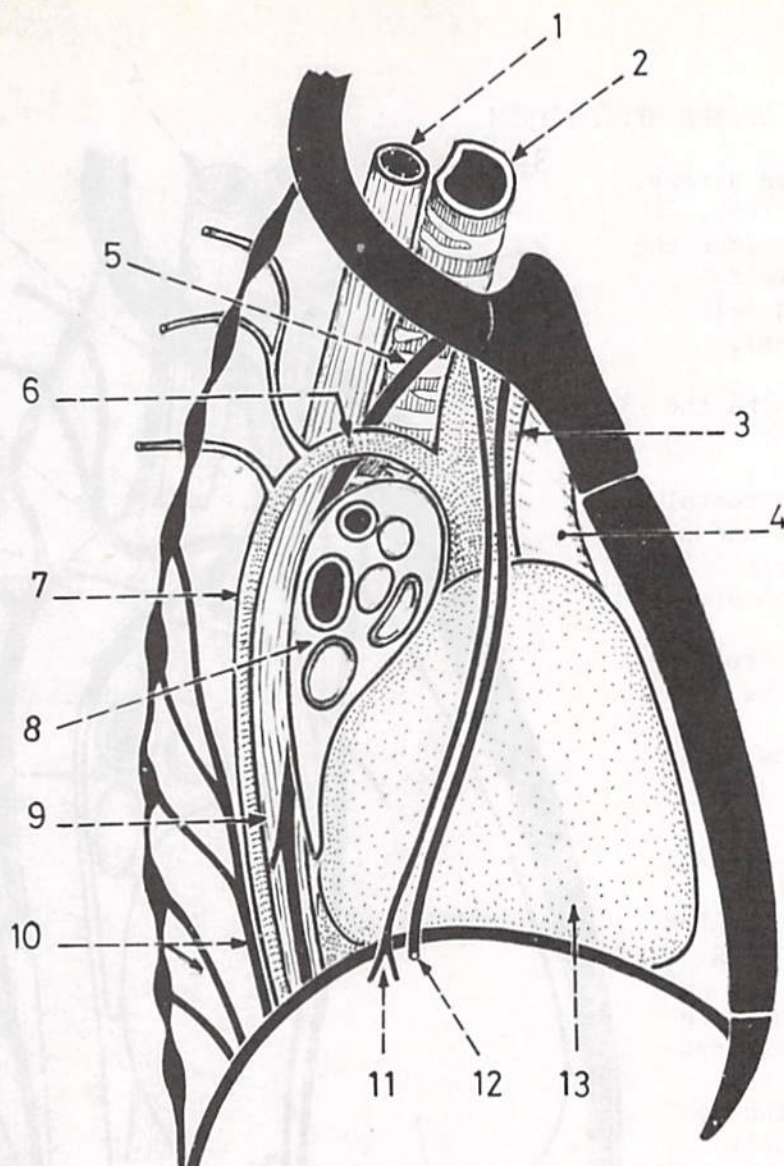
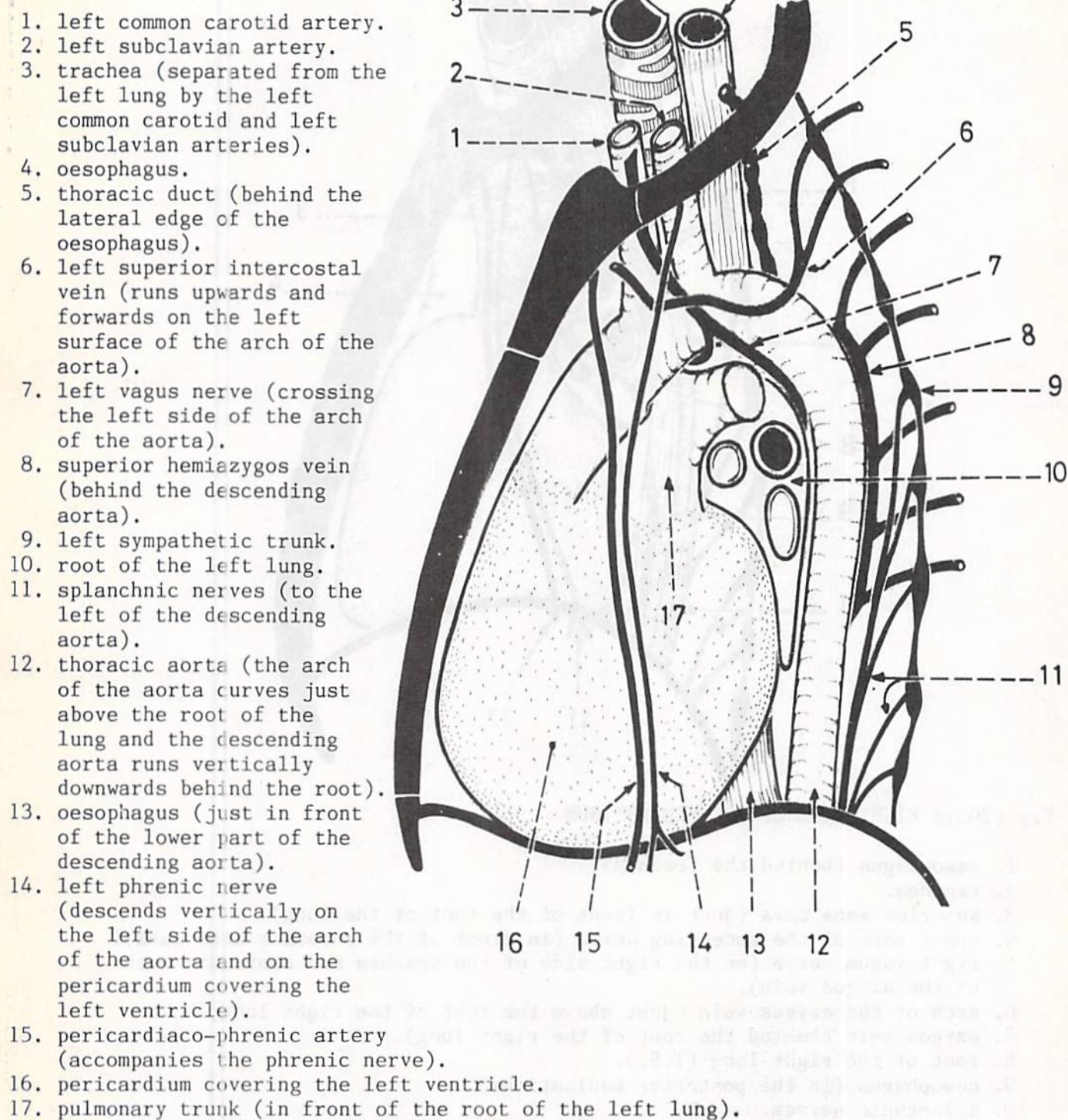


Fig.(205): RIGHT SIDE OF THE MEDIASTINUM

1. oesophagus (behind the trachea).
2. trachea.
3. superior vena cava (just in front of the root of the lung).
4. upper part of the ascending aorta (in front of the superior vena cava).
5. right vagus nerve (on the right side of the trachea and above the arch of the azygos vein).
6. arch of the azygos vein (just above the root of the right lung).
7. azygos vein (behind the root of the right lung).
8. root of the right lung (T.S.).
9. oesophagus (in the posterior mediastinum).
10. splanchnic nerves.
11. right phrenic nerve (descends vertically on the right side of the superior vena cava and pericardium covering the right atrium).
12. pericardiophrenic artery (accompanying the phrenic nerve).
13. fibrous pericardium covering the right atrium.

* These structures have their impressions on the mediastinal surface of the right lung, and the root of the lung is taken as a guide for their identification.

Fig.(206): LEFT SIDE OF THE MEDIASTINUM



* These structures have their impressions on the mediastinal surface of the left lung, and the root of the lung is taken as a guide for their identification.

LUNGS

SURFACES AND BORDERS

Fig.(207): OUTLINE OF THE LUNG

The lung occupies the side of the chest cavity with its apex projecting upwards into the thoracic inlet and its base (inferior surface) related to the diaphragm. It has 3 borders (anterior, inferior, posterior) and 2 surfaces (costal and medial).

1. apex of the lung (projecting into the thoracic inlet).
2. anterior border of the lung (behind the sternum).
3. inferior border of the lung.
4. costal surface of the lung (related to the ribs and inter-costal spaces).
5. posterior border (close to the vertebral column).

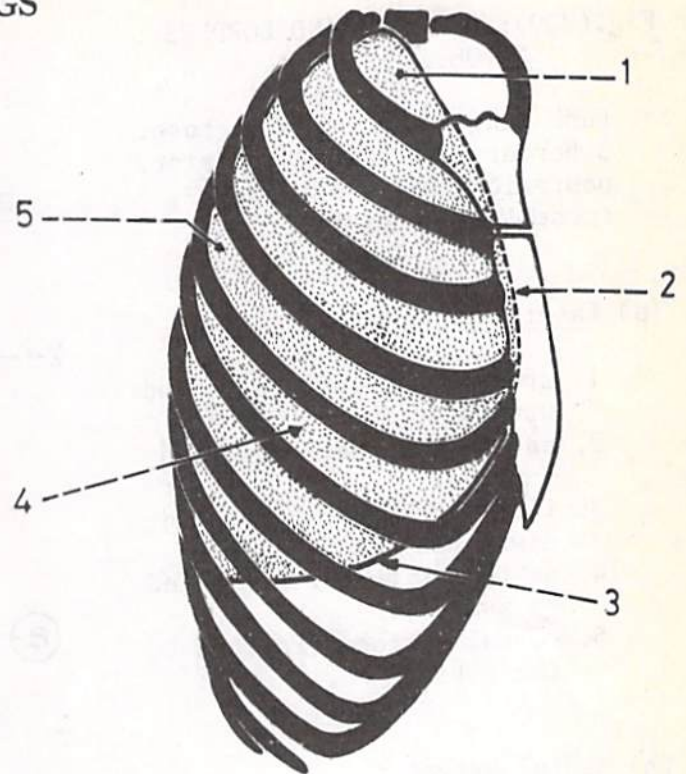


Fig.(208): CONNECTIONS OF THE LUNG

Each lung is connected by its root with the trachea (through the principal bronchus) and with the heart (through the pulmonary artery and veins).

1. principal bronchus (connected with the trachea).
2. pulmonary artery and veins (connected with the heart).

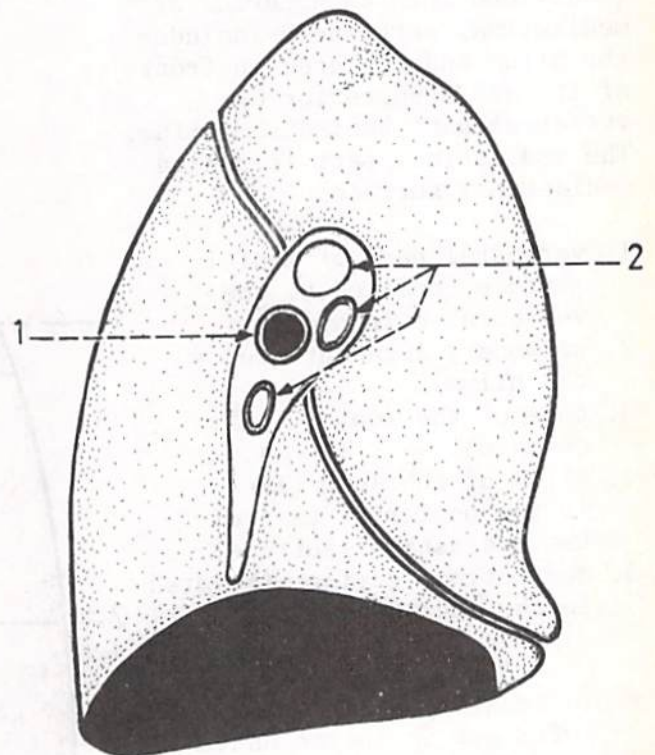
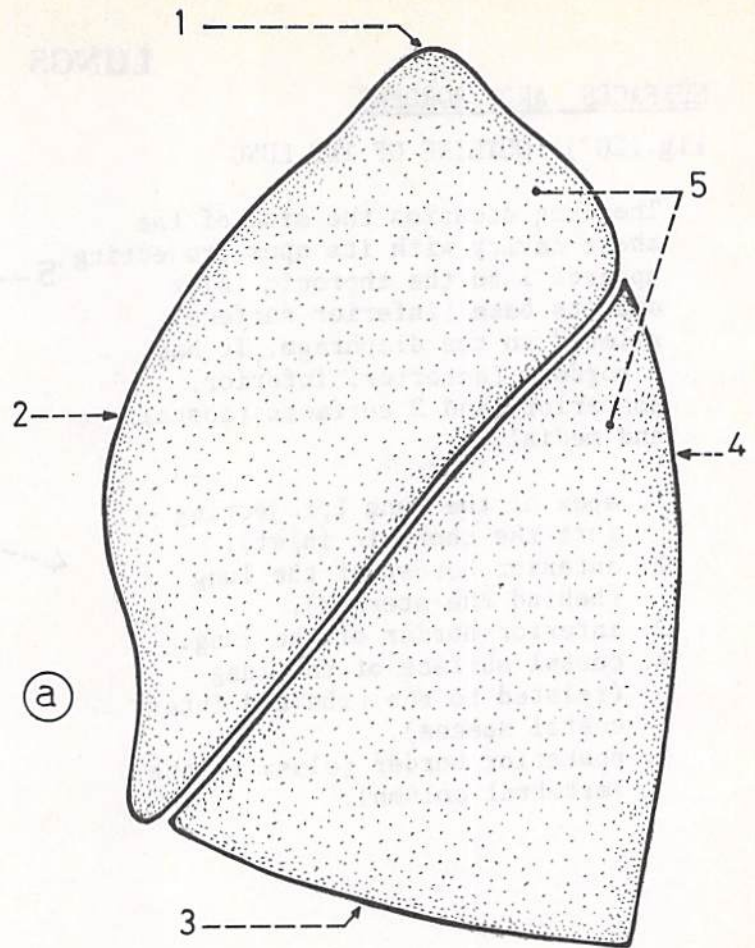


Fig.(209): SURFACES AND BORDERS OF THE LUNG

Each lung has an apex, a base, 3 borders (anterior, inferior, posterior) and 2 surfaces (costal and medial).

(a) Lateral aspect:

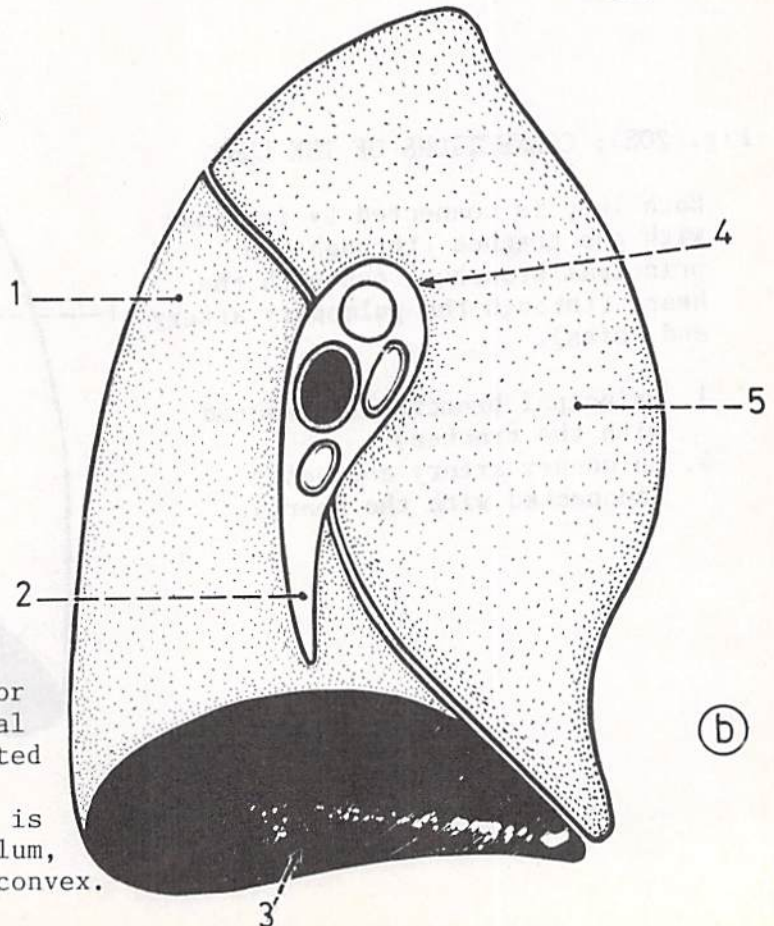
1. apex of the lung (directed upwards).
2. anterior border (directed forwards).
3. inferior border (directed downwards).
4. posterior border (directed backwards).
5. costal surface (related to the ribs).



(b) Medial aspect :

The medial surface of the lung is divided into an anterior or mediastinal part which includes the hilum and the area in front of it, and a posterior or vertebral part behind the hilum. The mediastinal part is called mediastinal surface.

1. vertebral part of medial surface (related to the vertebral column).
2. pulmonary ligament (below the hilum).
3. base of the lung (highly concave).
4. hilum of the lung (lies in the posterior part of the mediastinal surface).
5. mediastinal surface (related to the mediastinum).



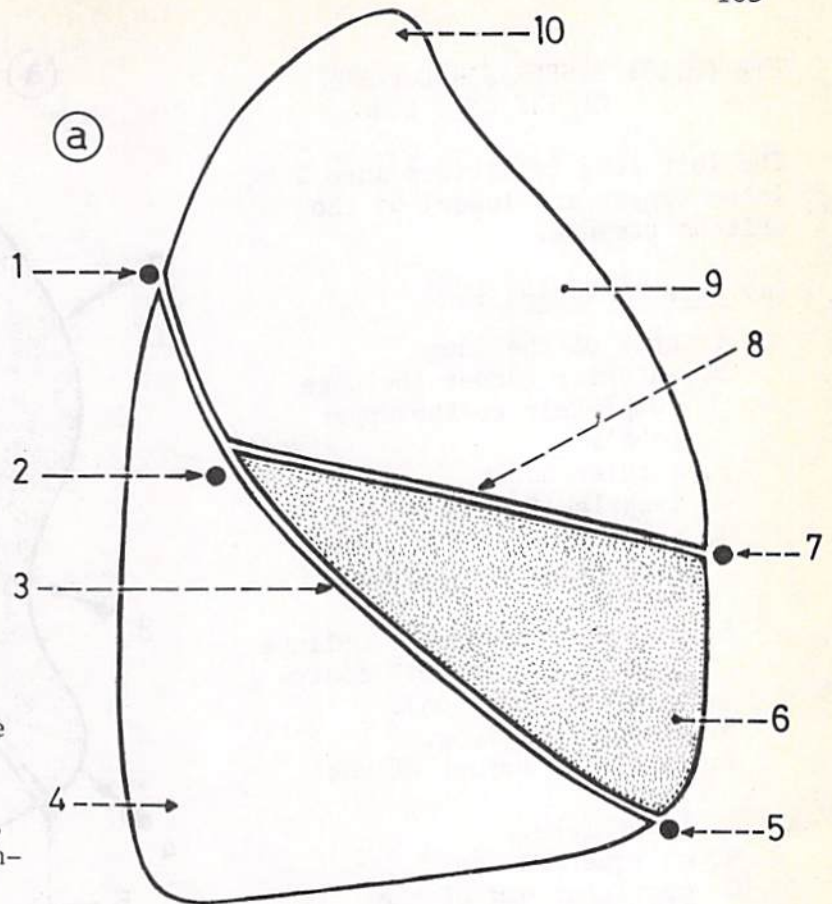
* To identify a lung as right or left: put it in the anatomical position with its apex directed upward and its base directed downward. Its medial surface is concave and marked by the hilum, while its costal surface is convex.

Fig.(210): FISSURES AND LOBES
OF THE RIGHT LUNG

The right lung is divided into 3 lobes (upper, middle and lower) by 2 fissures (oblique and horizontal).

(a) Lateral aspect :

1. posterior end of the oblique fissure (opposite the 3rd thoracic spine).
2. point of meeting of the transverse and oblique fissures (at the 6th rib in the midaxillary line).
3. oblique fissure below the middle lobe.
4. lower lobe.
5. anterior end of the oblique fissure (at the 6th costochondral junction).
6. middle lobe (wedge-shaped).
7. anterior end of the horizontal fissure (opposite the 4th costal cartilage).
8. horizontal fissure (between the upper and middle lobes).
9. upper lobe.
10. apex of the lung.



(b) Medial aspect :

1. horizontal fissure.
2. middle lobe (it stops posteriorly at the hilum and does not extend to the posterior border of the lung).
3. lower end of the oblique fissure.
4. base of the lung.
5. lower lobe.
6. hilum.
7. upper end of the oblique fissure (this fissure is interrupted at the hilum).
8. upper lobe.
9. apex of the lung.

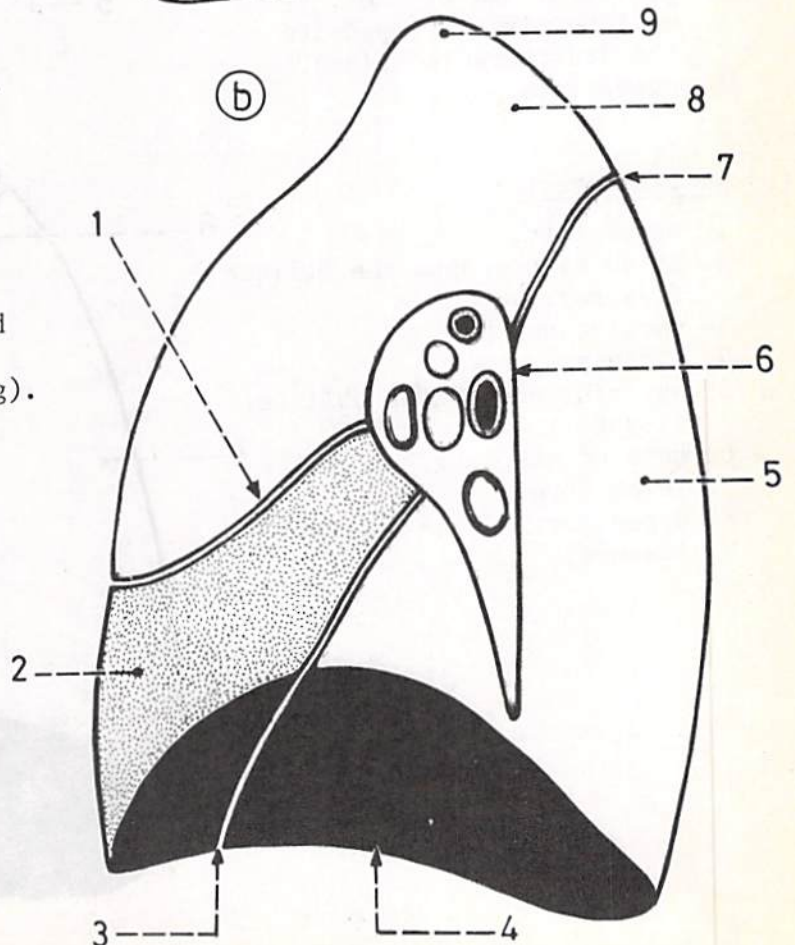
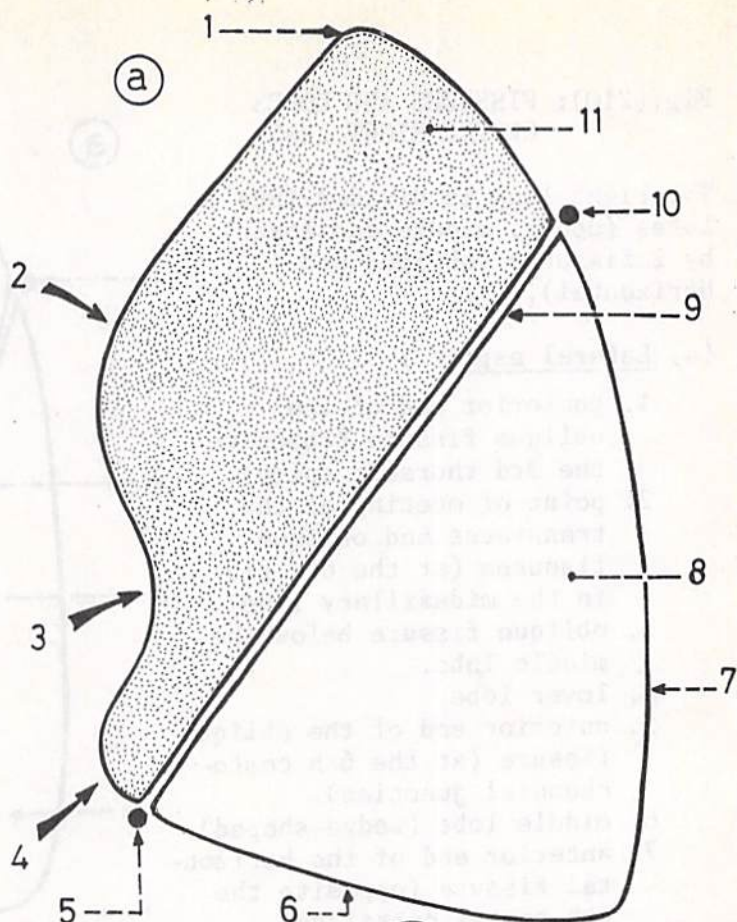


Fig.(211): FISSURES AND LOBES OF THE LEFT LUNG

The left lung is divided into 2 lobes (upper and lower) by the oblique fissure.

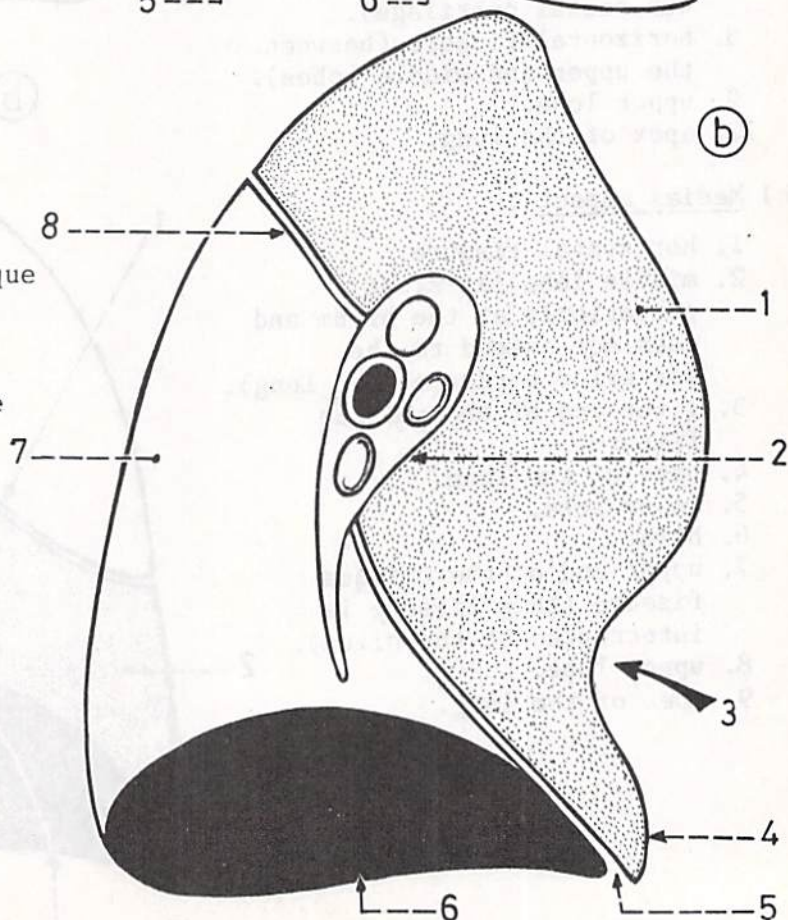
(a) Lateral aspect :

1. apex of the lung.
2. anterior border (belongs completely to the upper lobe).
3. cardiac notch.
4. lingula (a tongue-like projection of the upper lobe below the cardiac notch).
5. anterior end of the oblique fissure (at the 6th costochondral junction).
6. base of the lung.
7. posterior border of the lung.
8. lower lobe.
9. oblique fissure.
10. posterior end of the oblique fissure (opposite the 3rd thoracic spine).
11. upper lobe.



(b) Medial aspect :

1. upper lobe.
2. hilum (interrupts the oblique fissure).
3. cardiac notch.
4. lingula.
5. anterior end of the oblique fissure.
6. base of the lung.
7. lower lobe.
8. upper part of the oblique fissure.



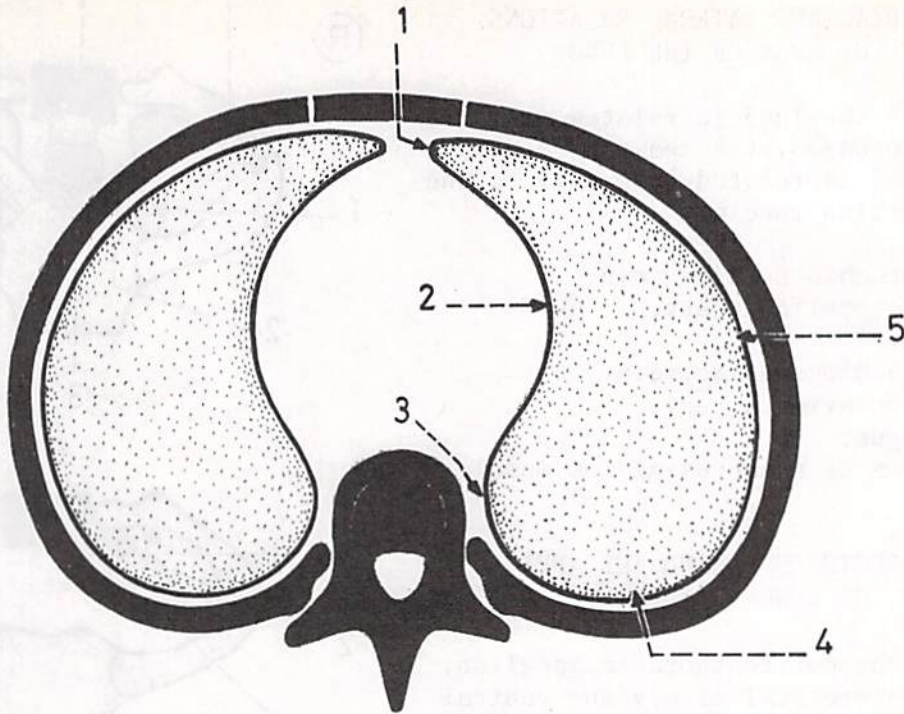


Fig.(212): SURFACES AND BORDERS OF THE LUNG (T.S.)

1. anterior border (projects forwards behind the sternum).
2. mediastinal part of the medial surface (related to the mediastinum).
3. vertebral part of the medial surface (related to the side of the vertebral column).
4. posterior border (thick and rounded).
5. costal surface.

Fig.(213): LOBE OF THE AZYGOS VEIN

It is an abnormal lobe which is partially separated from the medial part of the upper lobe by a fissure which contains the terminal part of the azygos vein. This lobe varies in size and sometimes it includes the apex of the lung.

1. lobe of azygos vein.
2. terminal part of azygos vein.

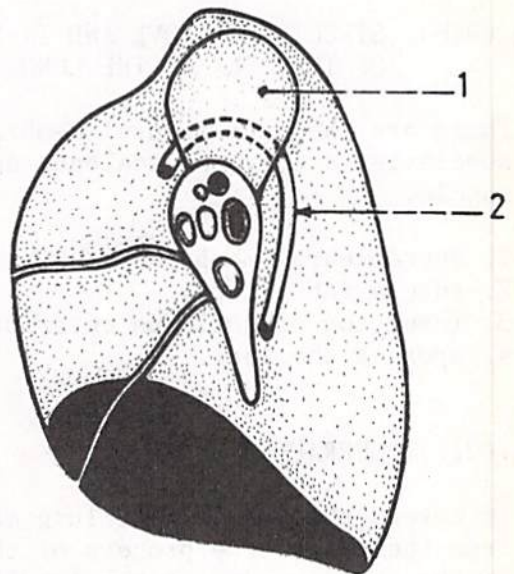


Fig.(214): MEDIAL AND LATERAL RELATIONS OF THE APEX OF THE LUNG

The apex of the lung is related medially to the oesophagus, trachea and related vessels, and is related laterally to the scalenus medius muscle.

1. right brachiocephalic vein.
2. brachiocephalic artery.
3. trachea.
4. left brachiocephalic vein.
5. left subclavian artery.
6. oesophagus.
7. insertion of scalenus medius muscle.

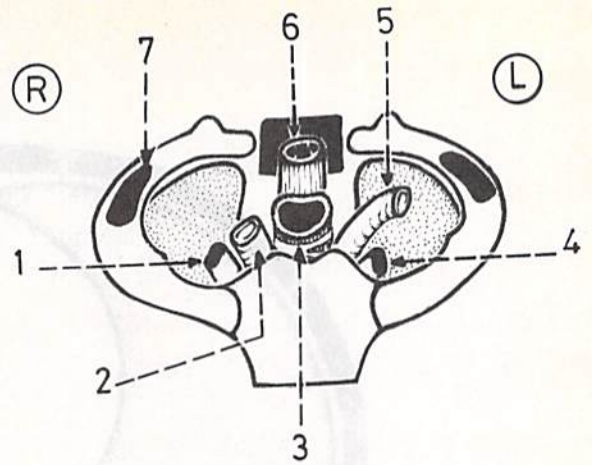
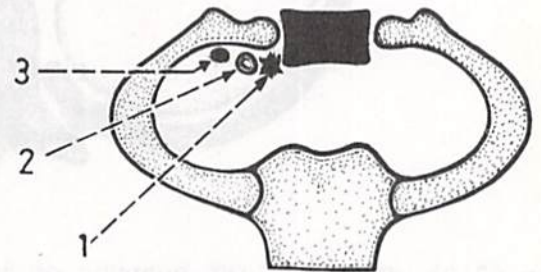


Fig.(215): STRUCTURES BEHIND THE APEX OF THE LUNG

These are the cervicothoracic ganglion, superior intercostal artery and ventral primary ramus of the 1st thoracic nerve.

1. cervicothoracic ganglion.
2. superior intercostal artery.
3. ventral primary ramus of 1st thoracic nerve.



* These 3 structures lie in front of the neck of the 1st rib.

Fig.(216): STRUCTURES ABOVE AND IN FRONT OF THE APEX OF THE LUNG

These are the suprapleural membrane, subclavian artery and scalenus anterior muscle.

1. suprapleural membrane.
2. subclavian artery.
3. insertion of scalenus anterior muscle.
4. apex of the lung.

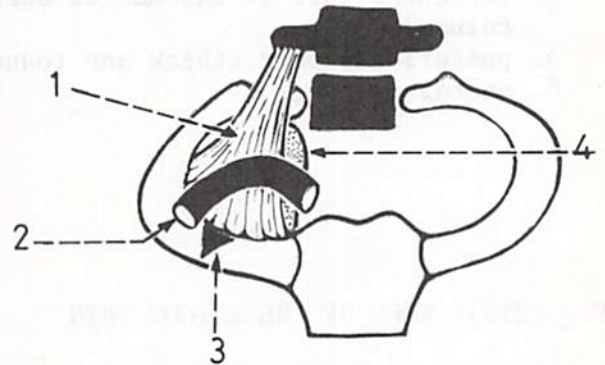


Fig.(217): SUPRAPLEURAL MEMBRANE

It covers the apex of the lung extending from the transverse process of the 7th C.V. to the inner border of the 1st rib.

1. transverse process of 7th C.V.
2. suprapleural membrane.
3. apex of the lung.

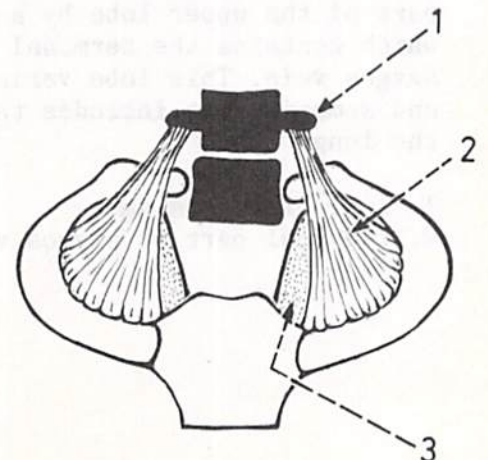


Fig.(218): THE SUPRAPLEURAL MEMBRANE COVERING THE APEX OF THE LUNG

1. transverse process of 7th C.V.
2. apex of the lung and its covering of cervical pleura.
3. suprapleural membrane (closes the lateral part of the inlet of the chest).
4. 1st rib.

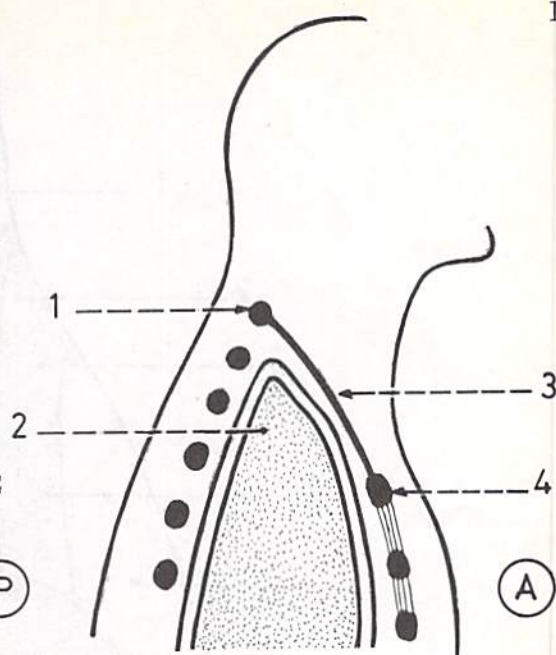
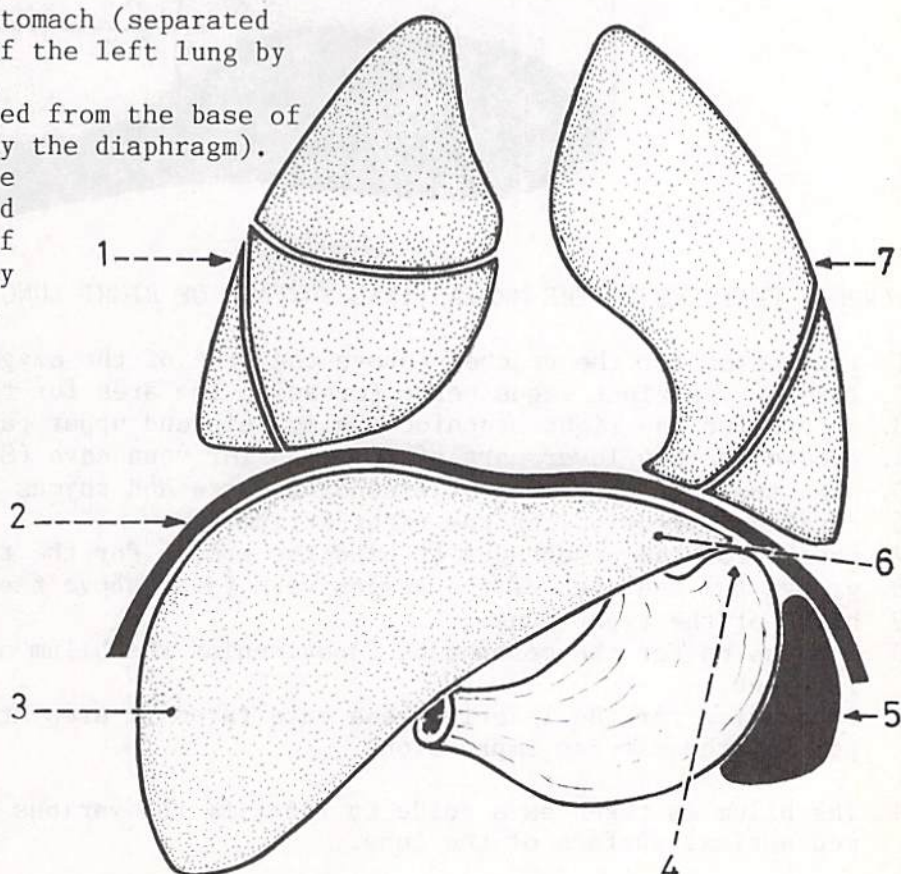


Fig.(219): RELATIONS OF THE BASE OF THE LUNG

The base of the lung is related to the diaphragm which separates it from the right lobe of the liver on the right side, and from the left lobe of the liver in addition to the fundus of the stomach and spleen on the left side.

1. right lung.
2. diaphragm.
3. right lobe of the liver (separated from the base of the right lung by the diaphragm).
4. fundus of the stomach (separated from the base of the left lung by the diaphragm).
5. spleen (separated from the base of the left lung by the diaphragm).
6. left lobe of the liver (separated from the base of the left lung by the diaphragm).
7. left lung.



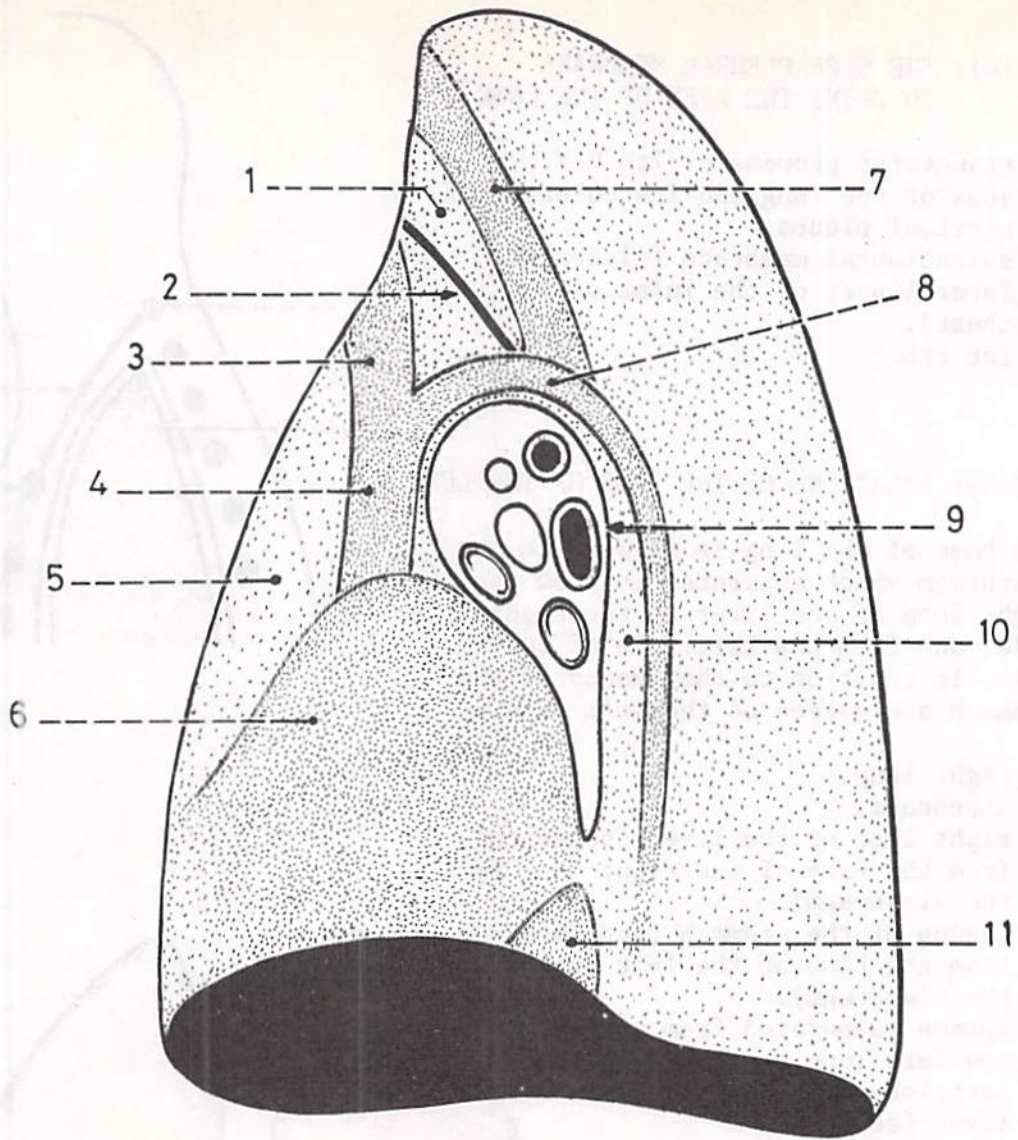


Fig.(220): FEATURES OF THE MEDIASTINAL SURFACE OF RIGHT LUNG

1. impression for the trachea (above the arch of the azygos vein).
2. line of the right vagus nerve (crossing the area for the trachea).
3. groove for the right brachiocephalic vein and upper part of S.V.C.
4. groove for the lower part of the superior vena cava (S.V.C.).
5. area for the upper part of ascending aorta and thymus gland.
6. cardiac impression for the right atrium.
7. groove for the oesophagus (behind the groove for the trachea).
8. groove for the arch of the azygos vein (just above the hilum of the lung).
9. hilum of the right lung.
10. impression for the oesophagus (just behind the hilum and the pulmonary ligament).
11. impression for the inferior vena cava (a small area at the postero-inferior part of the cardiac impression).

* The hilum is taken as a guide to identify the various impressions on the mediastinal surface of the lung.

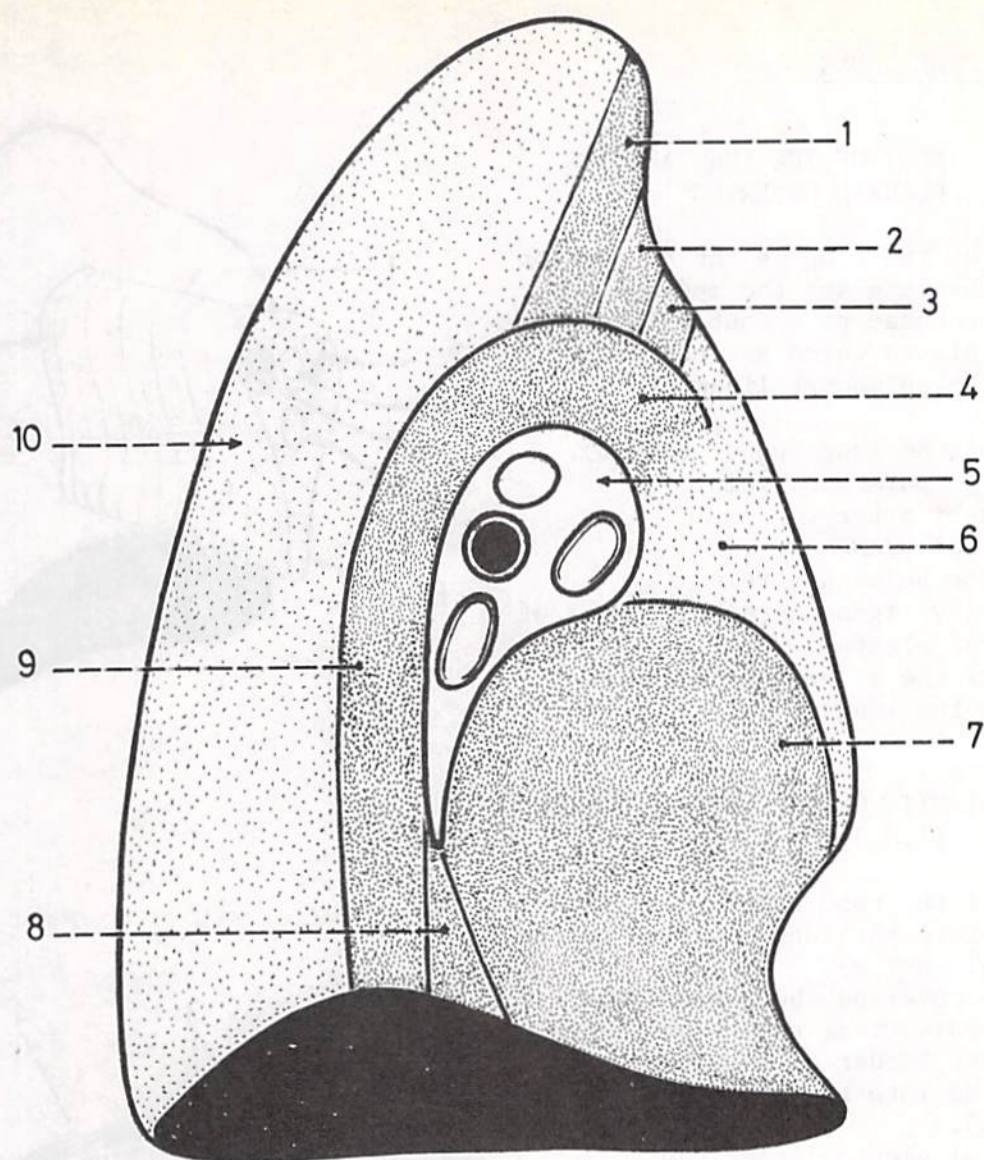


Fig.(221): FEATURES OF THE MEDIASTINAL SURFACE OF LEFT LUNG

1. groove for the oesophagus.
2. groove for the left subclavian artery.
3. groove for the left common carotid artery.
4. groove for the arch of the aorta (a deep groove just above the hilum).
5. hilum of the left lung.
6. impression for the pulmonary trunk (just in front of the upper part of the hilum).
7. cardiac impression for the left ventricle and part of the right ventricle).
8. impression for the oesophagus (a small area just in front of the lower end of the groove for the descending aorta).
9. groove for the descending aorta (a deep vertical groove behind the hilum and the pulmonary ligament).
10. vertebral part of the medial surface.

* The hilum is taken as a guide to identify the various impressions on the mediastinal surface of the lung.

ROOT OF THE LUNG

Fig.(222): ROOT OF THE LUNG AND ITS PLEURAL COVERING

The root of the lung is the connection between the lung and the mediastinum. It is surrounded by a double layer of visceral pleura which extends below it to form the pulmonary ligament.

1. root of the lung (upper border).
2. superior pulmonary vein.
3. pulmonary artery.
4. principal bronchus.
5. inferior pulmonary vein.
6. pulmonary ligament (double layer of visceral pleura).
7. site of the hilum (where the root enters the lung).

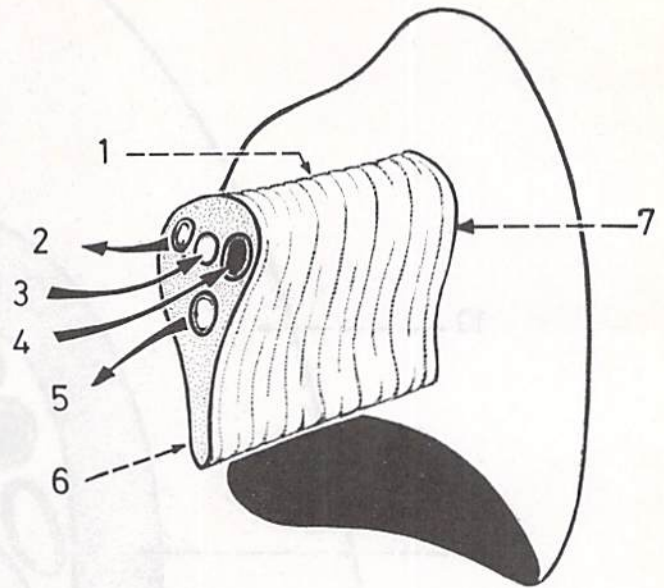


Fig.(223): SITE OF THE ROOT OF THE LUNG (T.S.)

1. site of the root of the lung (the site where the lung invaginates the pleural cavity).
2. pleura covering the mediastinum.
3. costomediastinal recess of pleura.
4. anterior border of the lung (projects forwards into the costomediastinal recess).
5. parietal pleura lining the chest wall.
6. pleural cavity.
7. visceral pleura covering the lung (pulmonary pleura).
8. visceral pleura bordering the root of the lung.

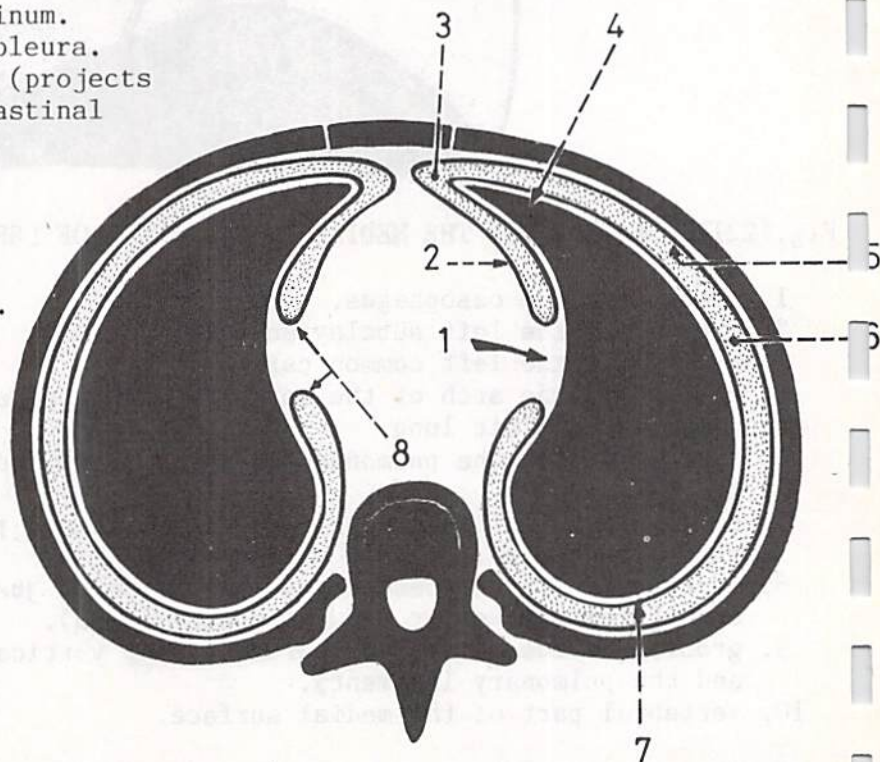


Fig.(224): POSITION OF THE ROOT
OF THE LUNG

The root of the lung lies opposite the 5th, 6th and 7th thoracic vertebrae.

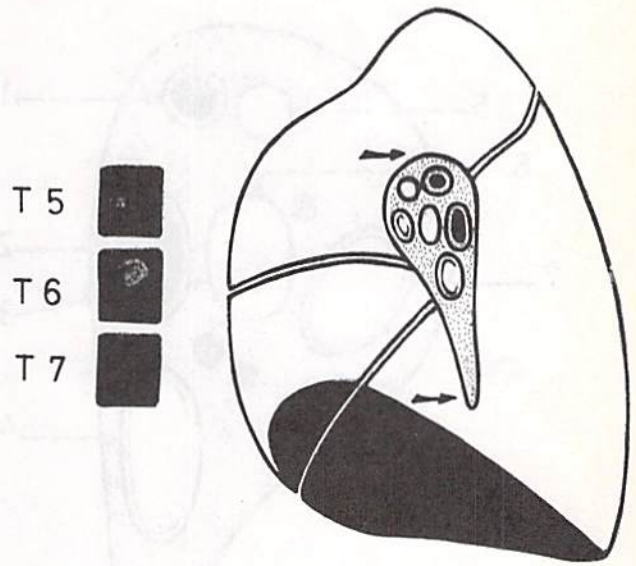
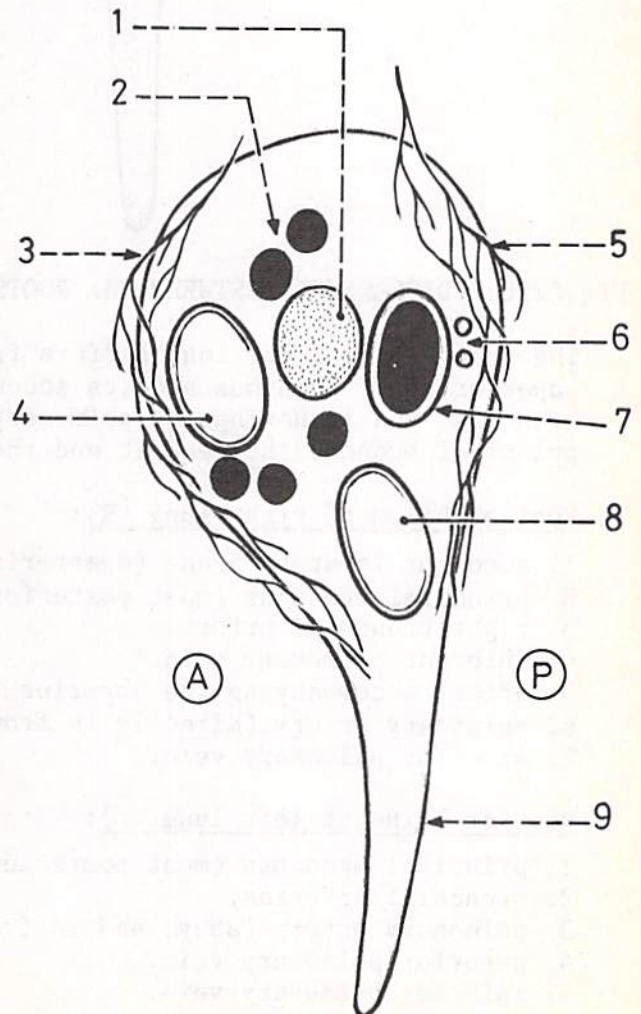


Fig.(225): CONTENTS OF THE ROOT
OF THE LUNG

These are the principal bronchus, pulmonary artery, 2 pulmonary veins, bronchial vessels, pulmonary plexuses of nerves and bronchopulmonary lymph nodes.

1. pulmonary artery.
2. bronchopulmonary lymph nodes.
3. anterior pulmonary plexus (autonomic fibres).
4. superior pulmonary vein (most anterior).
5. posterior pulmonary plexus (autonomic fibres).
6. bronchial vessels (on the back of the bronchus).
7. principal bronchus (most posterior, with plates of cartilage in its wall).
8. inferior pulmonary vein (lowermost).
9. pulmonary ligament (double layer of pleura below the root).



* The contents of the root are also the contents of the hilum.

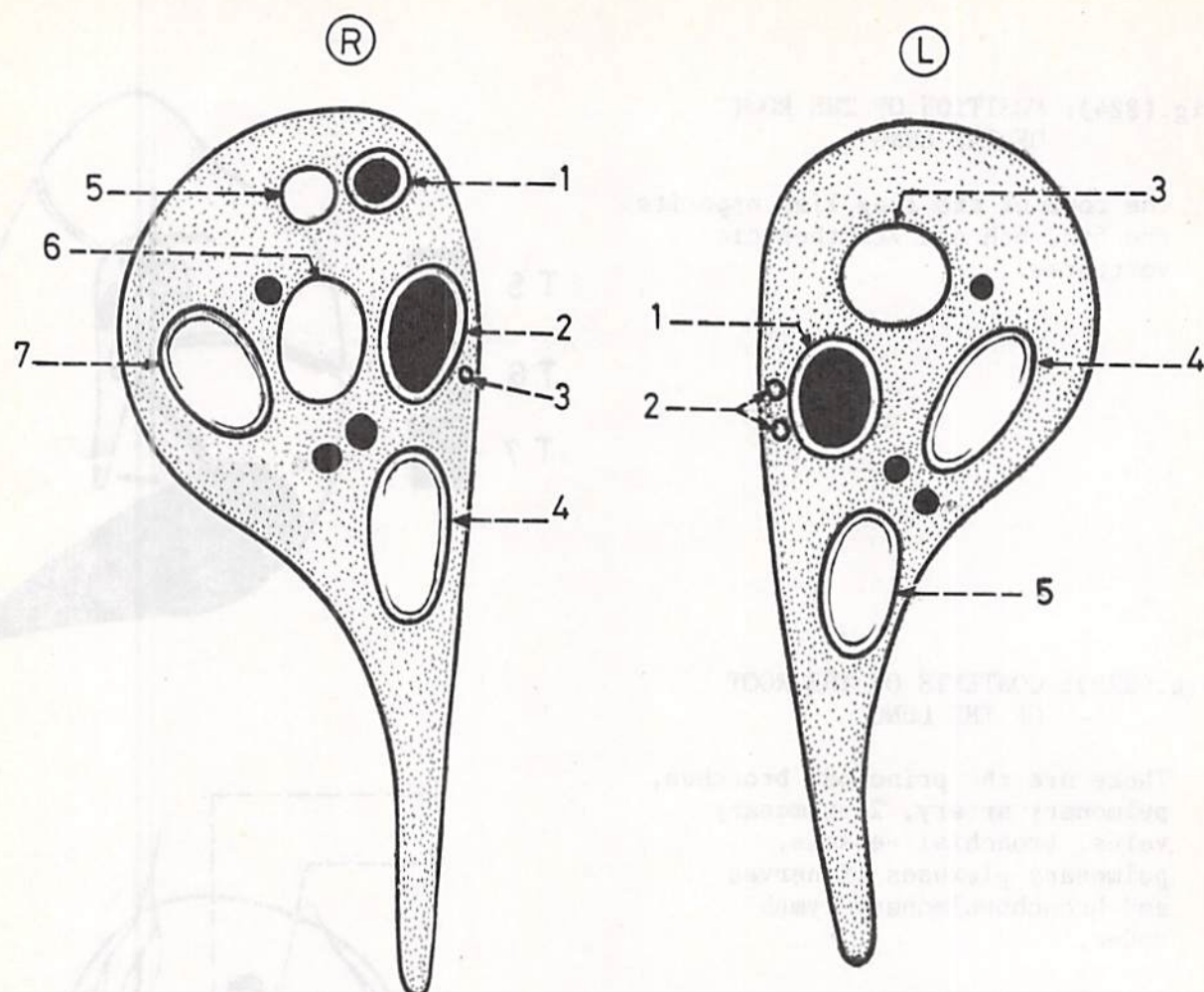


Fig.(226): DIFFERENCES BETWEEN THE ROOTS OF BOTH LUNGS

The root of the right lung differs from that of the left lung in having the superior lobar bronchus and its accompanying artery situated above the principal bronchus, and in having the pulmonary artery placed directly in front of the principal bronchus between it and the superior pulmonary vein.

Root or hilum of right lung (R):

1. superior lobar bronchus (eparterial bronchus).
2. principal bronchus (most posterior).
3. right bronchial artery.
4. inferior pulmonary vein.
5. artery accompanying the superior lobar bronchus.
6. pulmonary artery (directly in front of the principal bronchus).
7. superior pulmonary vein.

Root or hilum of left lung (L):

1. principal bronchus (most posterior).
2. bronchial arteries.
3. pulmonary artery (above and in front of the principal bronchus).
4. superior pulmonary vein.
5. inferior pulmonary vein.

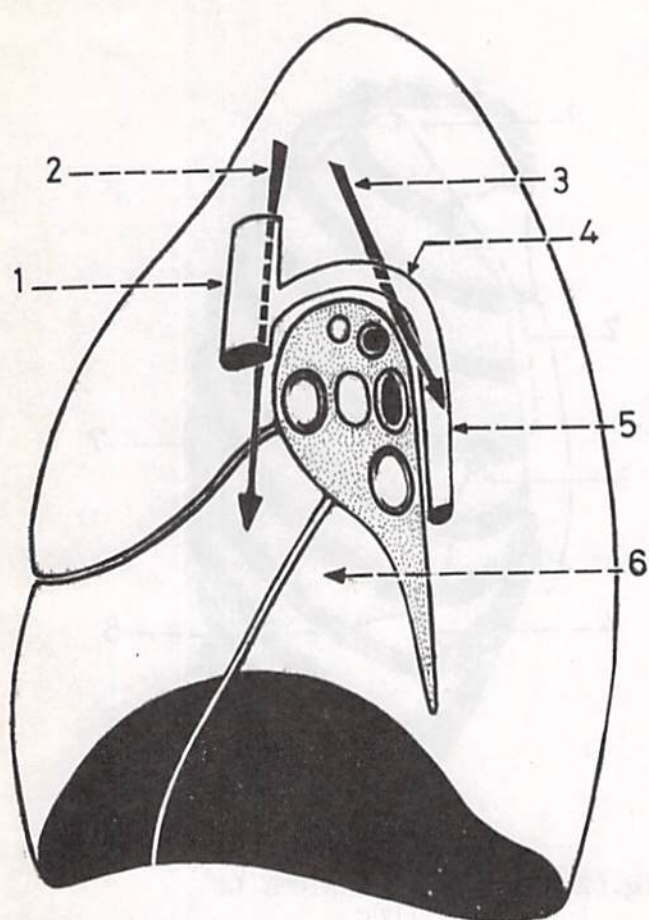


Fig.(227): RELATIONS OF THE ROOT OF THE RIGHT LUNG

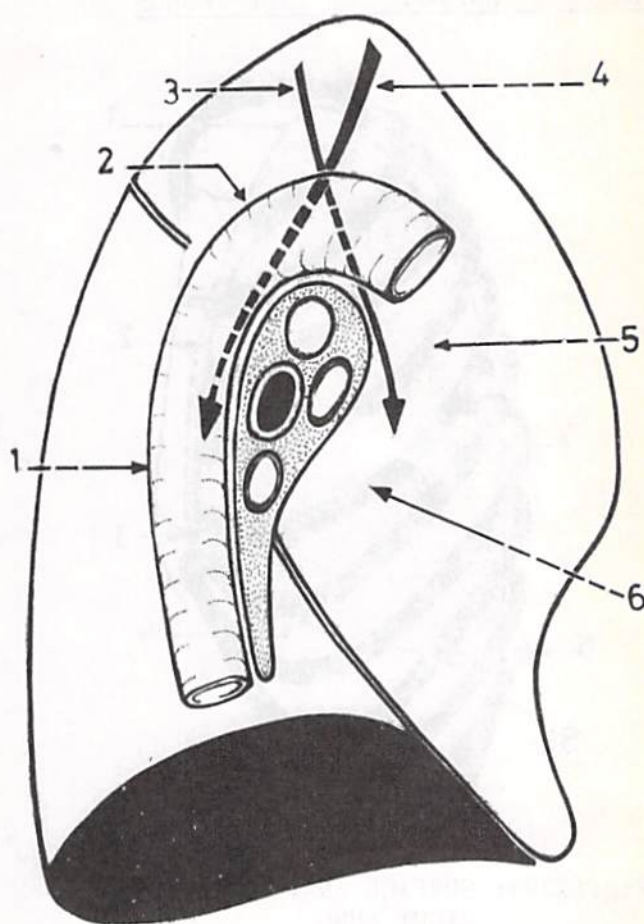


Fig.(228): RELATIONS OF THE ROOT OF THE LEFT LUNG

1. superior vena cava (in front).
2. right phrenic nerve (in front).
3. right vagus nerve (behind).
4. arch of azygos vein (above).
5. terminal part of azygos vein (behind).
6. right atrium (below and in front).

* The root of the right lung is surrounded by veins.

1. descending aorta (behind).
2. arch of the aorta (above).
3. left phrenic nerve (in front).
4. left vagus nerve (behind).
5. area for pulmonary trunk (in front).
6. area for left ventricle (below and in front).

* The root of the left lung is surrounded mainly by arteries.

SURFACE ANATOMY OF THE LUNGS

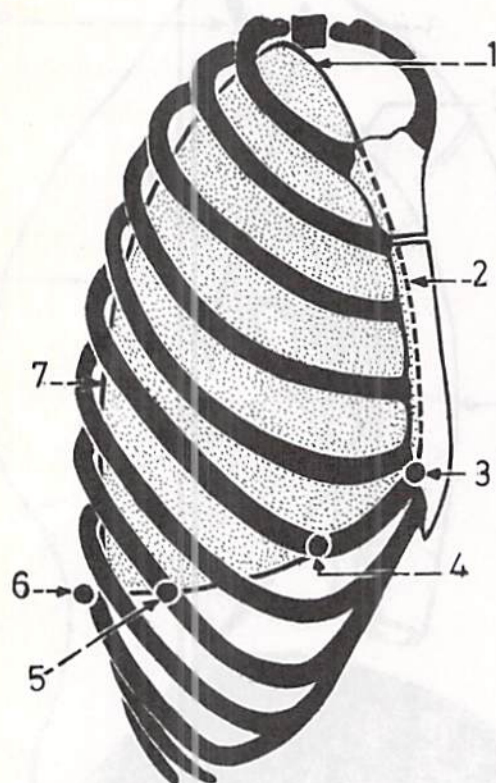


Fig.(229): SURFACE ANATOMY OF RIGHT LUNG

- * Apex of the lung: represented by a curved line convex upwards (1) reaching 3 cm above the medial 1/3 of the clavicle.
- * Anterior border: represented by a line (2) drawn downwards and medially from the right sternoclavicular joint to the sternal angle near the midline, and then vertically downwards to the 6th sternocostal junction (3).
- * Inferior border: represented by a line which cuts the 6th rib in the midclavicular line (4), the 8th rib in the midaxillary line (5) and the 10th rib at 5 cm from the midline of the back (6).
- * Posterior border: represented by a vertical line (7) drawn from the posterior end of the inferior border below to the apex of the lung above.

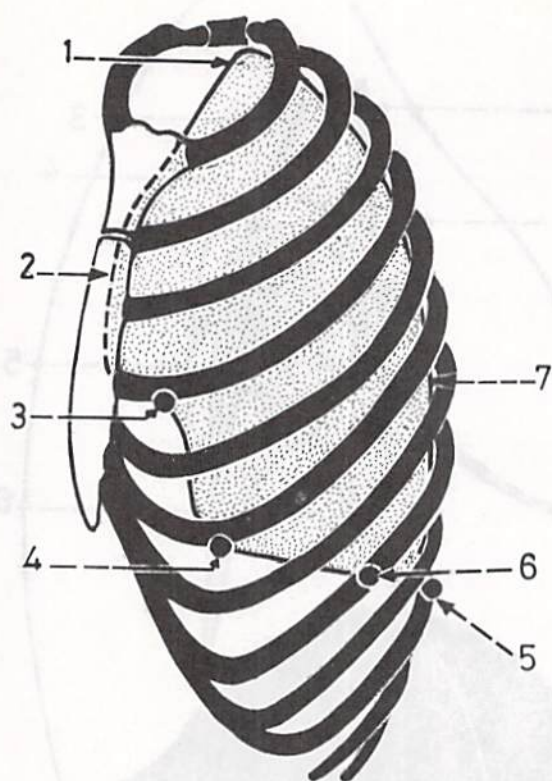


Fig.(230): SURFACE ANATOMY OF LEFT LUNG

- * Apex of the lung (1): the same as in the right lung.
- * Anterior border: represented by a line (2) drawn downwards and medially from the left sternoclavicular joint to the sternal angle near the midline. The line then passes vertically downwards to the level of the 4th costal cartilage where it deviates to the left for 4 cm (3) and then continues downwards to the 6th costal cartilage 4 cm from the midline (4).
- * Inferior border: begins at the 6th rib in the midclavicular line (4), cuts the 8th rib in the midaxillary line (6) and the 10th rib at a point 5 cm from the midline of the back (5).
- * Posterior border (7): same as in the right lung.
- * Note that the surface anatomy of the 2 lungs is the same except for the anterior border, because of the presence of the cardiac notch in the left lung.

Fig.(231): SURFACE ANATOMY OF THE CARDIAC NOTCH OF THE LEFT LUNG

The cardiac notch begins at the level of the left 4th costal cartilage where the anterior border deviates to the left for 4 cm from the midline and then descends to the 6th costal cartilage.

1. 4th costal cartilage.
2. oblique fissure.
3. 6th costal cartilage.
4. the distance between the cardiac notch and the midline (4 cm).

* Note that the cardiac notch corresponds to the bare area of the pericardium.

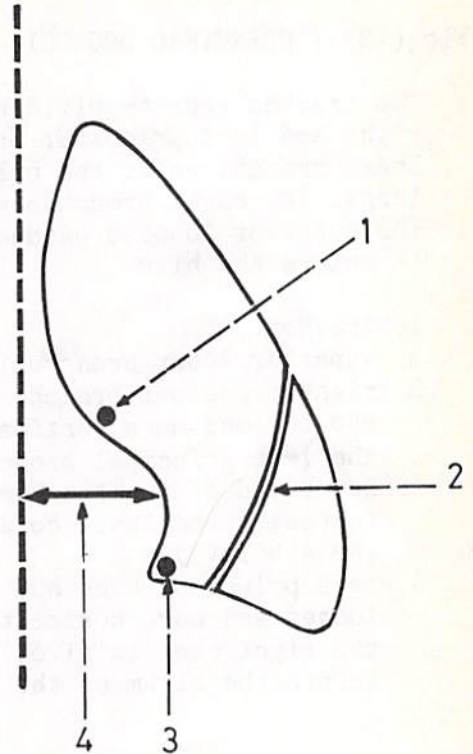


Fig.(232): SURFACE ANATOMY OF THE OBLIQUE FISSURE OF THE LUNG

The oblique fissure is represented by an oblique line beginning posteriorly at the 3rd thoracic spine and runs downwards and laterally following the 6th rib as far as the costal margin anteriorly.

1. posterior end of the oblique fissure (opposite the 3rd T.V. and lies 6 cm below the apex of the lung).
2. root of the spine of the scapula (opposite the posterior end of the oblique fissure).
3. the line of the oblique fissure coincides with the line of the 6th rib.
4. lower lobe of the lung.
5. the oblique fissure corresponds roughly to the medial border of the scapula when it rotates upwards in case the arm is abducted above the head.
6. the inferior angle of the scapula moves forwards in abduction of the arm above the head.

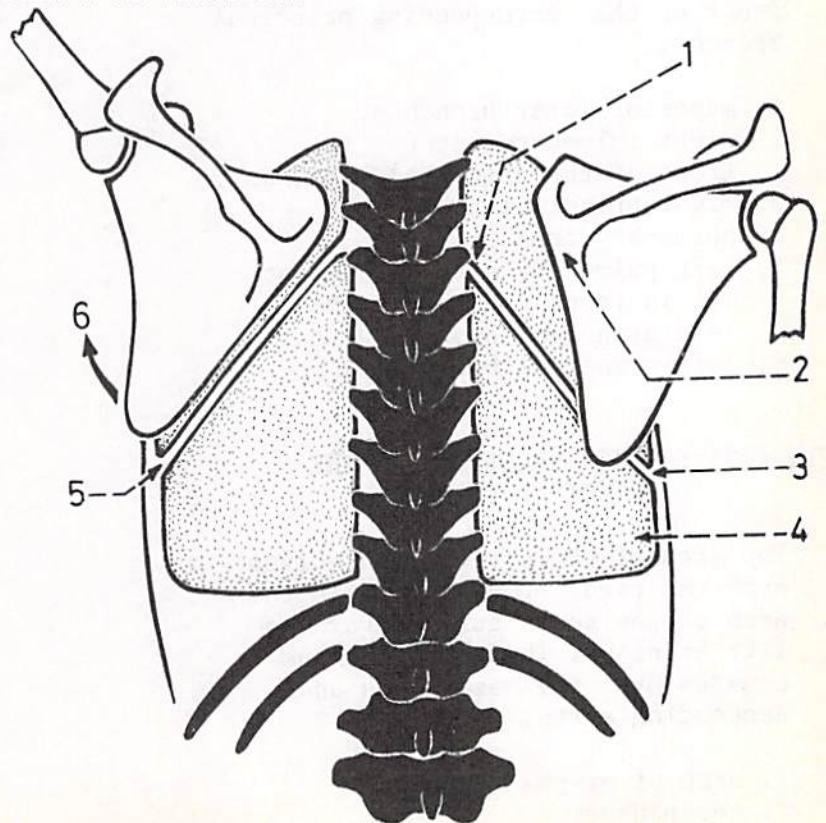


Fig.(233): PRINCIPAL BRONCHI

The trachea ends by dividing into right and left principal bronchi. These bronchi enter the hilum of the lungs. The right bronchus gives off the superior lobar bronchus before it enters the hilum.

1. trachea.
2. superior lobar bronchus.
3. right principal bronchus (wider, shorter and more vertical than the left principal bronchus).
4. lower end of the trachea (opposite the lower border of the 4th T.V.).
5. left principal bronchus (narrower, longer and more horizontal than the right one; it gives no divisions before the hilum of the lung).

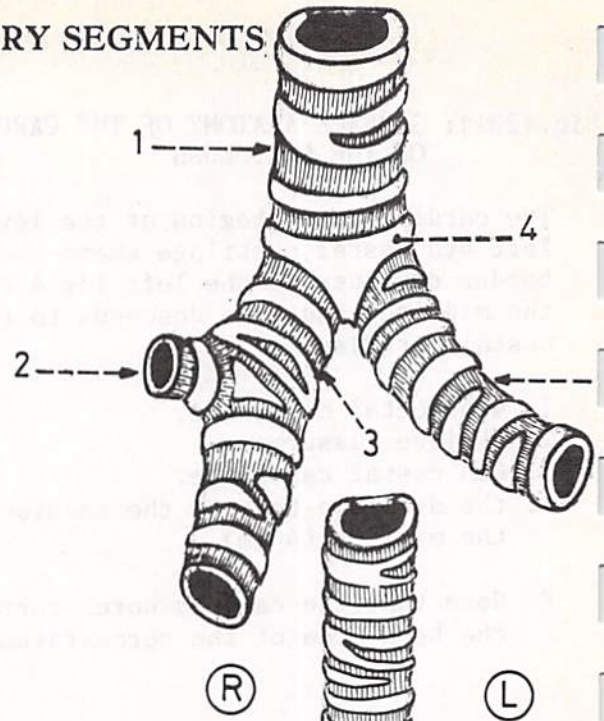


Fig.(234): RELATIONS OF THE PRINCIPAL BRONCHI TO THE PULMONARY ARTERIES

The pulmonary trunk divides just below the end of the trachea, and the 2 pulmonary arteries run in front of the corresponding principal bronchi.

1. superior lobar bronchus.
2. right pulmonary artery (in front of the principal bronchus).
3. right principal bronchus.
4. pulmonary trunk.
5. left pulmonary artery (lies at 1st in front then above the left principal bronchus).
6. left principal bronchus.

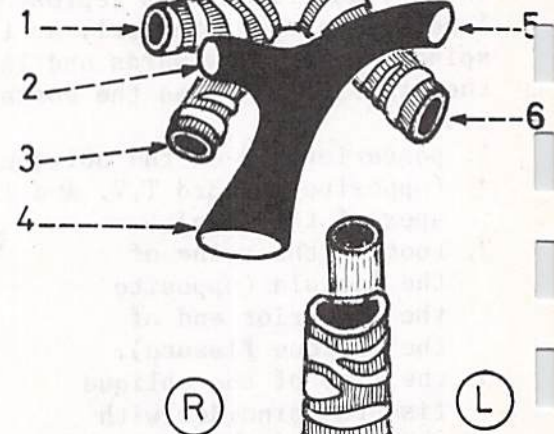


Fig.(235): OTHER RELATIONS TO THE PRINCIPAL BRONCHI

The arch of the azygos vein curves over the right bronchus, while the arch of the aorta curves over the left bronchus. The left bronchus crosses over the oesophagus and descending aorta.

1. arch of azygos vein,
2. oesophagus.
3. aorta.

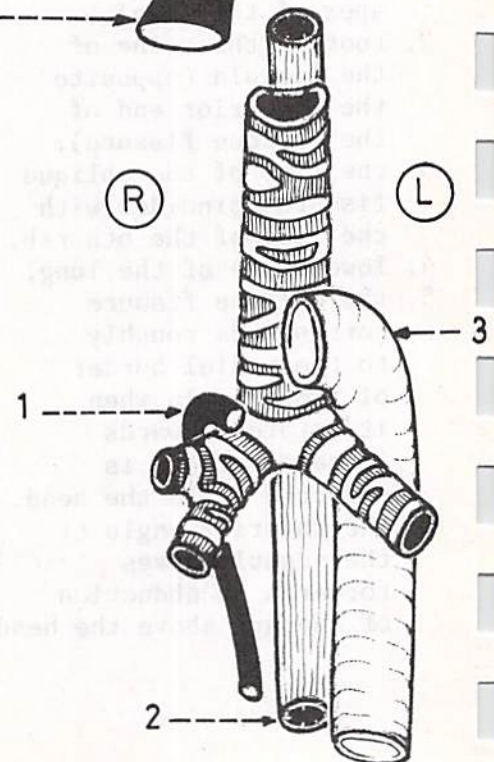


Fig.(236): SEGMENTAL BRONCHI

Each principal bronchus divides into lobar bronchi (3 on the right and 2 on the left), and each lobar bronchus divides into segmental bronchi to the bronchopulmonary segments.

1. apical bronchus (upwards & laterally).
2. posterior bronchus (backwards & laterally).
3. anterior bronchus (forwards & downwards).
4. on the right it is the lateral bronchus, while on the left it is the superior lingular bronchus.
5. on the right it is the medial bronchus, while on the left it is the inferior lingular bronchus.
6. anterior basal bronchus (forwards & downwards).
7. lateral basal bronchus (laterally & downwards).
8. posterior basal bronchus (backwards & downwards).
9. medial basal bronchus (medially & downwards). It is usually absent on the left side.
10. apical bronchus of lower lobe (directly backwards).

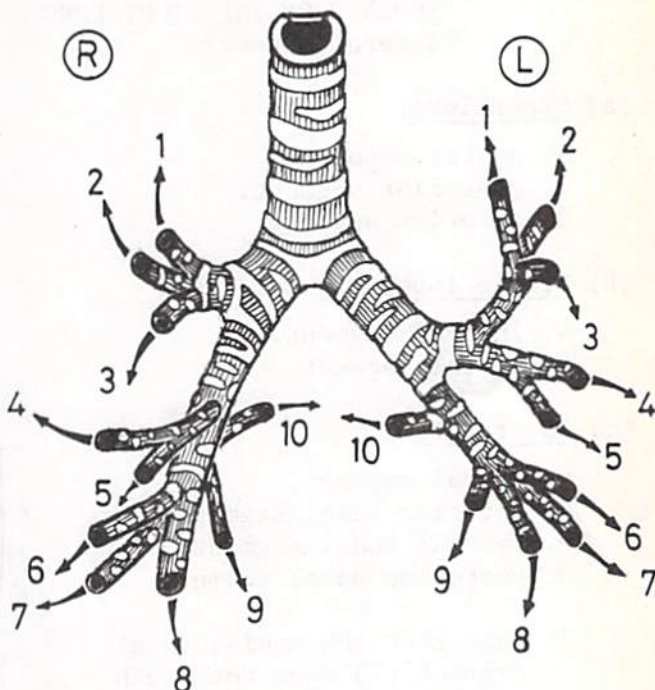
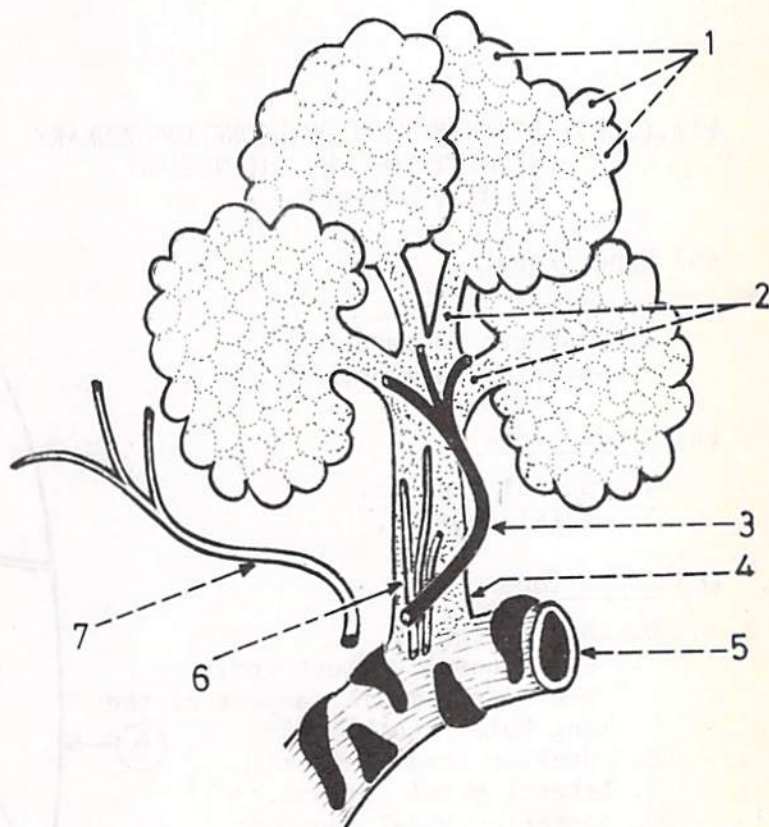


Fig.(237): CONSTITUENTS OF THE BRONCHOPULMONARY SEGMENT

These are: a mass of alveoli, segmental bronchus and its subdivisions, blood vessels and lymph vessels.

1. alveoli.
2. alveolar ducts.
3. segmental artery (a branch from the pulmonary artery).
4. bronchiole (a subdivision of the segmental bronchus).
5. segmental bronchus (a subdivision of the lobar bronchus).
6. lymph vessels.
7. segmental vein (a radicle of the pulmonary vein and runs in the plane between the segments).



* Each segmental bronchus is subdivided into a number of bronchioles, each of which is connected with a mass of alveolar ducts and alveoli.

Fig.(238): DISTRIBUTION OF BRONCHOPULMONARY SEGMENTS OF THE RIGHT LUNG (lateral aspect)

(a) Upper lobe:

1. apical segment.
2. posterior segment.
3. anterior segment.

(b) Middle lobe:

4. lateral segment.
5. medial segment.

(c) Lower lobe:

6. apical segment.
8. anterior basal segment.
9. lateral basal segment.
10. posterior basal segment.

* Note that the medial basal segment (7) does not reach the lateral surface of the lung.

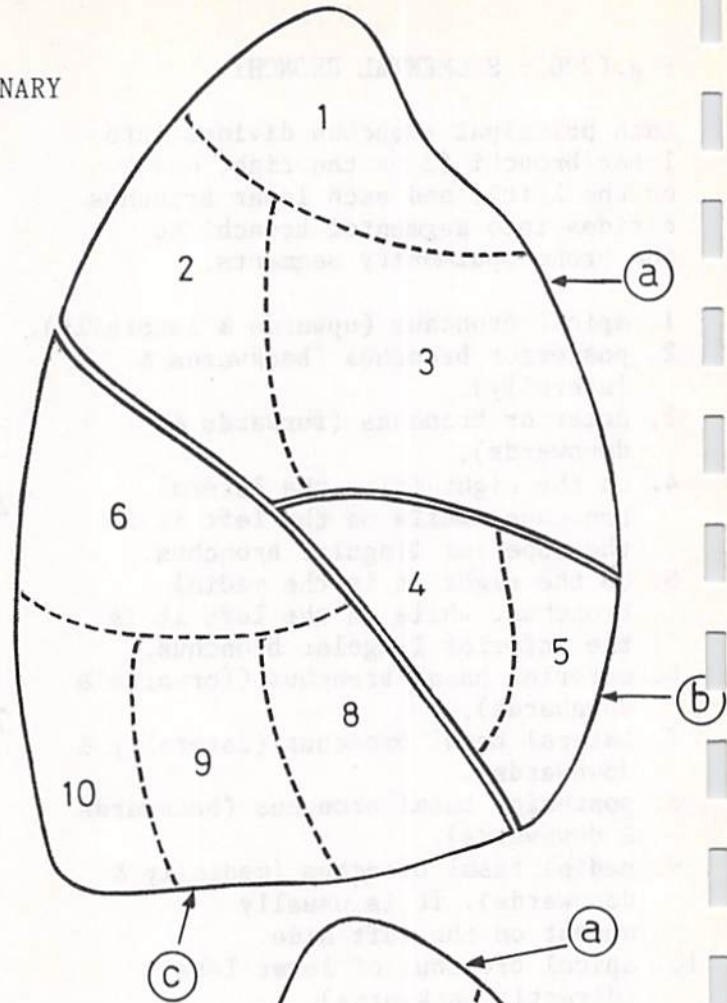


Fig.(239): DISTRIBUTION OF BRONCHOPULMONARY SEGMENTS OF THE RIGHT LUNG (medial aspect)

(a) Upper lobe:

1. apical segment.
2. posterior segment.
3. anterior segment.

(b) Middle lobe:

4. lateral segment.
5. medial segment.

(c) Lower lobe:

6. apical segment.
7. medial basal segment (only seen on the medial aspect of the lung below the hilum).
8. anterior basal segment.
9. lateral basal segment.
10. posterior basal segment.

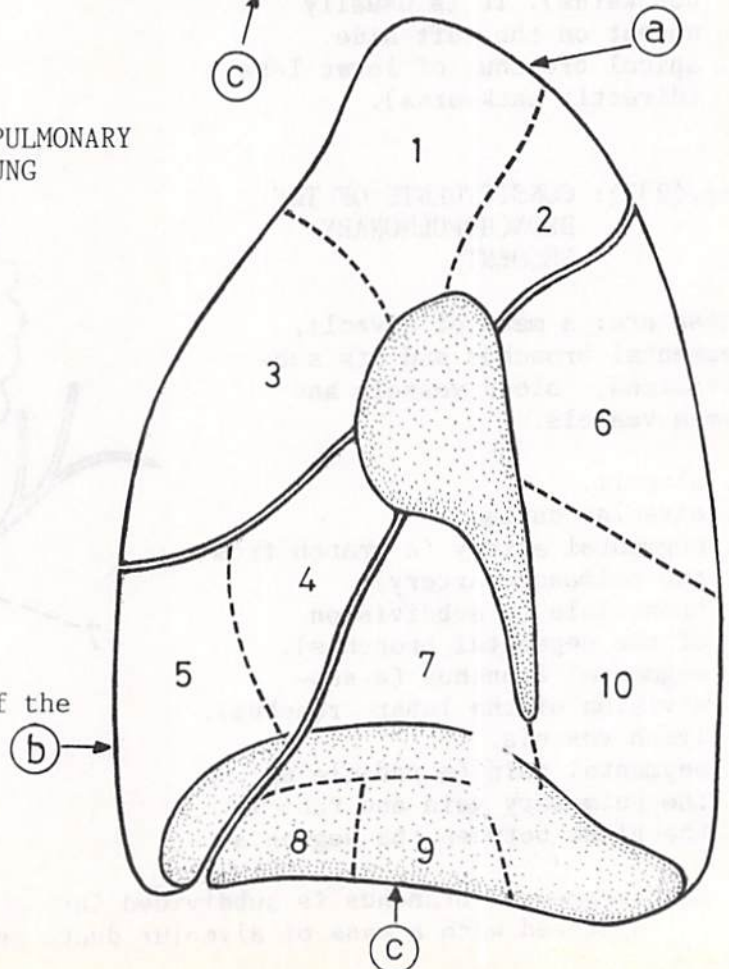


Fig.(240): DISTRIBUTION OF BRONCHOPULMONARY SEGMENTS OF THE LEFT LUNG (lateral aspect)

(a) Upper lobe:

1. apical segment.
2. posterior segment.
3. anterior segment.
4. superior lingular segment.
5. inferior lingular segment.

(b) Lower lobe:

6. apical segment.
8. anterior basal segment.
9. lateral basal segment.
10. posterior basal segment.

* Note that the medial basal segment (7) does not reach the lateral surface of the lung. This segment is usually absent in the left lung.

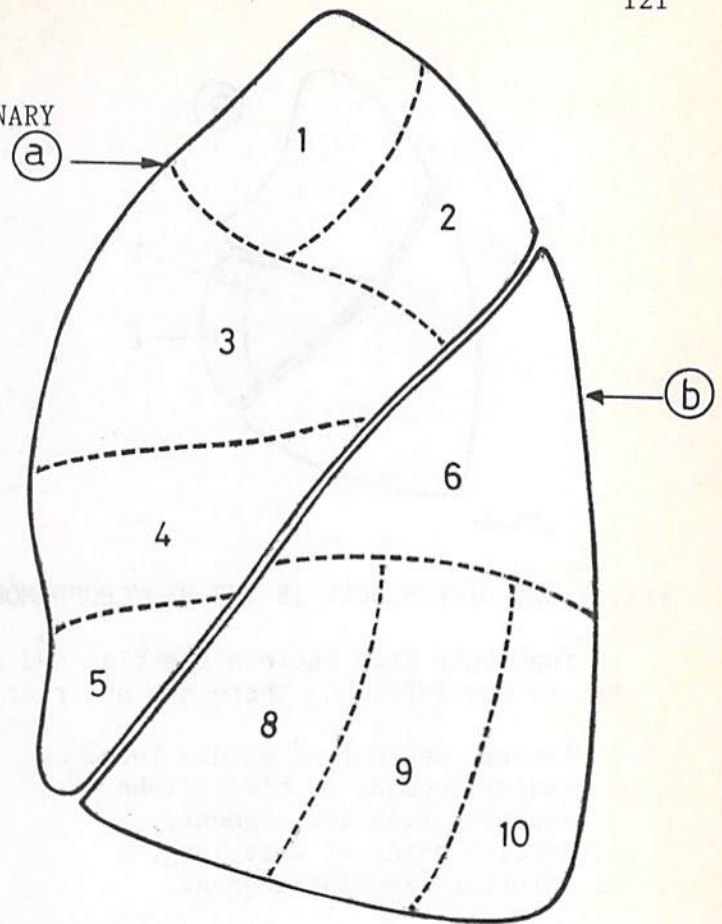


Fig.(241) DISTRIBUTION OF BRONCHOPULMONARY SEGMENTS OF THE LEFT LUNG (medial aspect)

(a) Upper lobe:

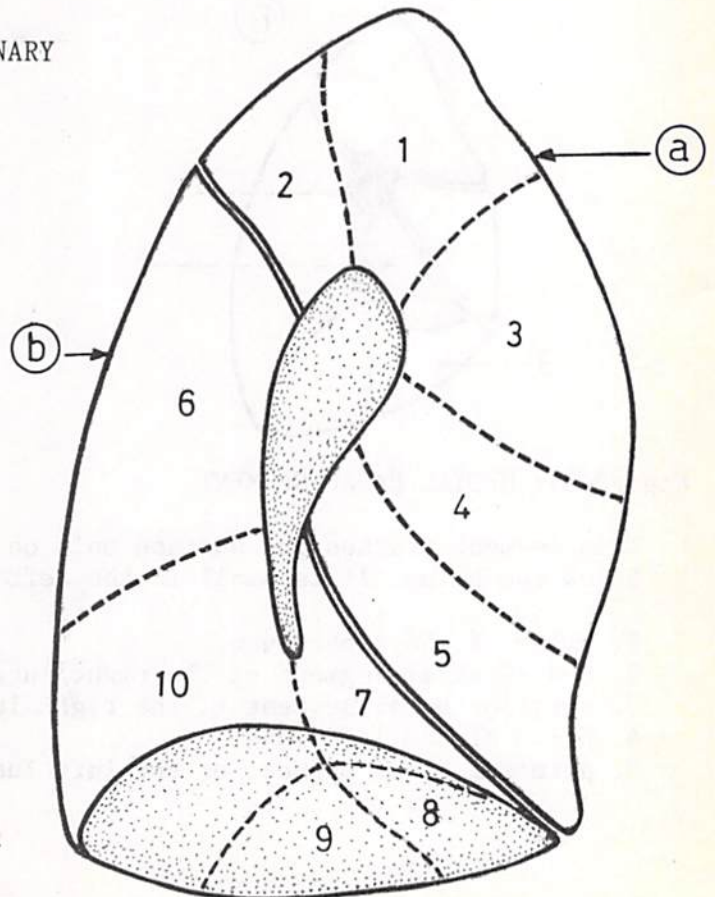
1. apical segment.
2. posterior segment.
3. anterior segment.
4. superior lingular segment.
5. inferior lingular segment.

(b) Lower lobe:

6. apical segment.
7. medial basal segment (usually absent).
8. anterior basal segment.
9. lateral basal segment.
10. posterior basal segment.

* Note that the lingular segments of the left lung correspond to the segments of the middle lobe of the right lung.

* The medial basal segment of the left lung is usually absent.



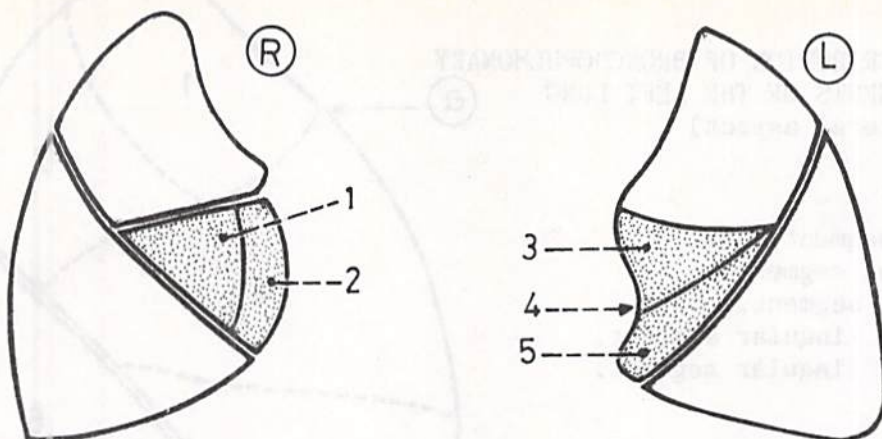


Fig.(242): DIFFERENCES IN THE BRONCHOPULMONARY SEGMENTS BETWEEN THE 2 LUNGS

In the right lung there are medial and lateral segments in the middle lobe, but in the left lung there are superior and inferior lingular segments instead.

1. lateral segment of middle lobe.
2. medial segment of middle lobe.
3. superior lingular segment.
4. cardiac notch of left lung.
5. inferior lingular segment.

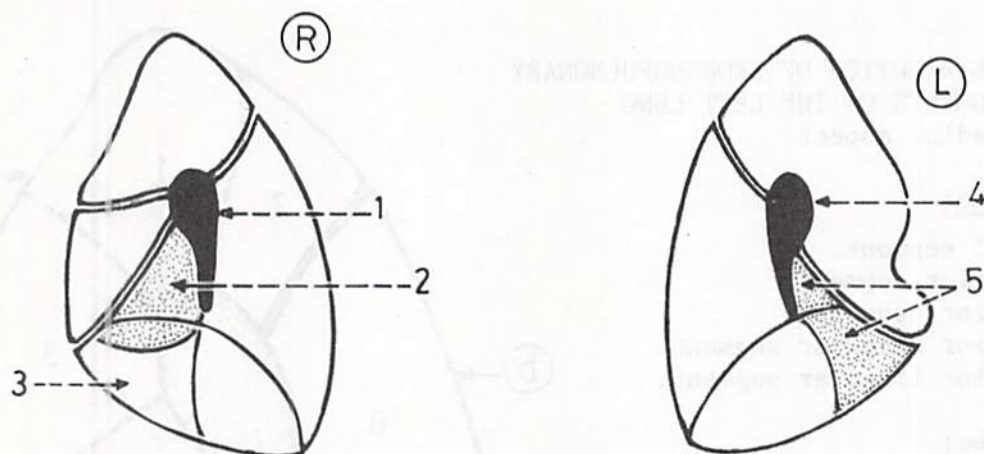


Fig.(243): MEDIAL BASAL SEGMENT

This segment reaches the surface only on the medial aspect of the lung, just below the hilum. It is small in the left lung and is usually absent.

1. hilum of the right lung.
2. medial basal segment of the right lung.
3. anterior basal segment of the right lung.
4. hilum of the left lung.
5. anterior basal segment of the left lung (replacing the medial basal segment).

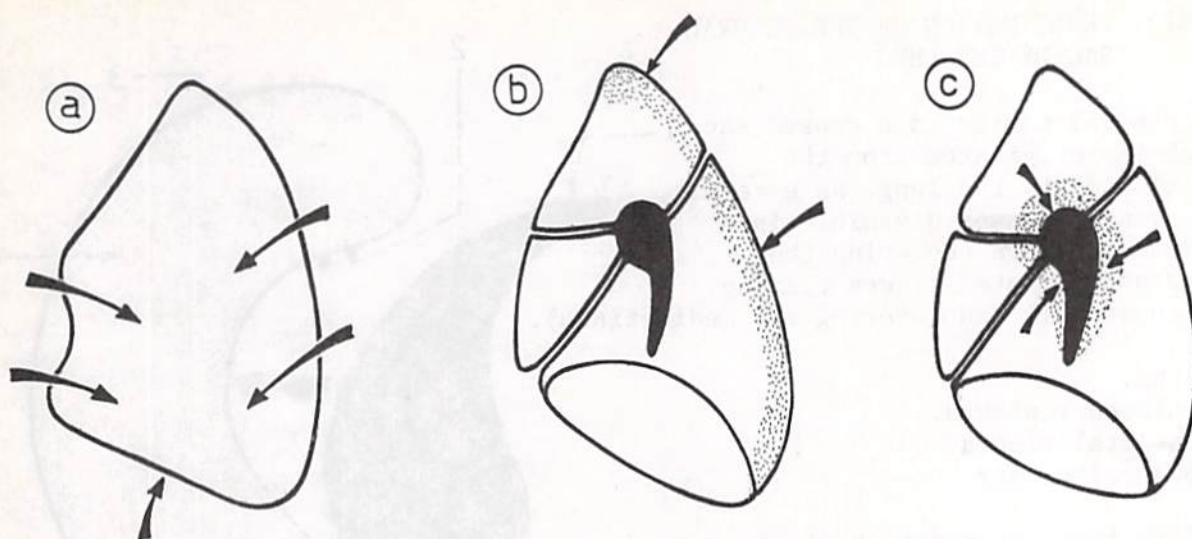


Fig.(244): DEGREE OF EXPANSION OF THE LUNG DURING INSPIRATION

- (a) Regions of great expansion: costal and diaphragmatic surfaces.
- (b) Regions of less expansion : apex and posterior border.
- (c) Regions of least expansion: the region close to the hilum.

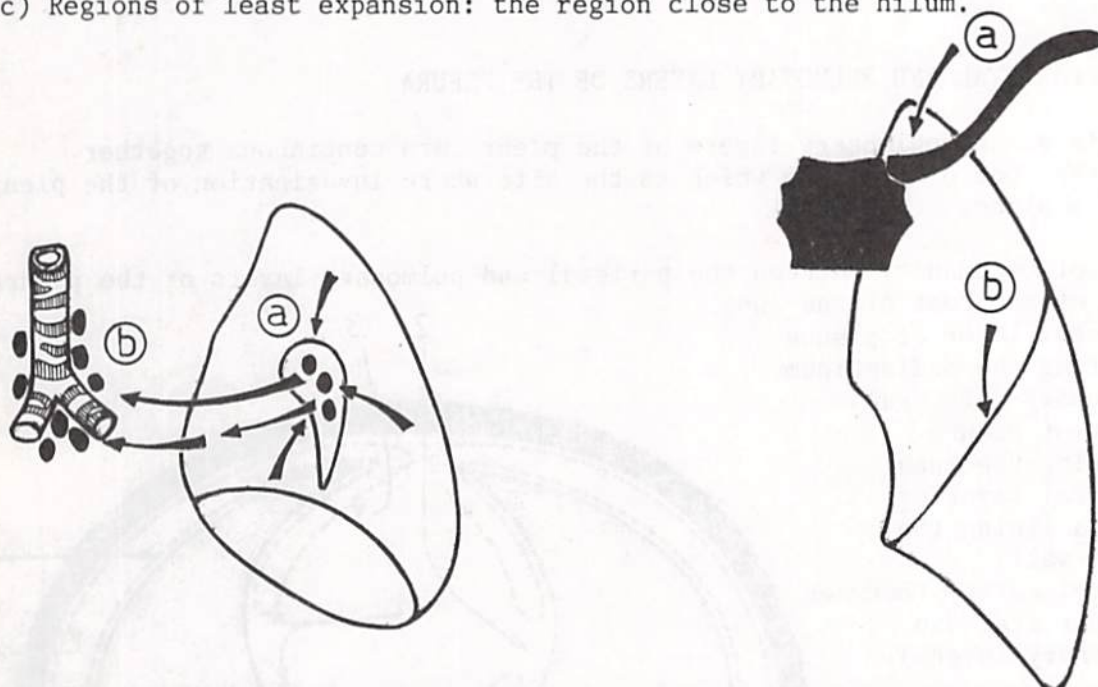


Fig.(245): LYMPH DRAINAGE OF THE LUNG

The lymph vessels of the lung drain into the bronchopulmonary lymph nodes (a) present in the root of the lung, and into the tracheo-bronchial lymph nodes (b) present at the bifurcation of the trachea.

Fig.(246): RADIOGRAPHY OF THE LUNG

In examining an X-ray of the lung, note that the apex lies above the clavicle (a), and that the lower limit of the upper lobe corresponds to the 6th rib (b).

PLEURA

Fig.(247): INVAGINATION OF THE PLEURAL SAC BY THE LUNG

The pleural cavity is a closed sac 1 which is invaginated from the medial side by the lung. As a result, the pleura becomes divisible into pulmonary pleura (covering the lung) and parietal pleura (lining the chest wall and covering the mediastinum).

1. lung.
2. pulmonary pleura.
3. parietal pleura.
4. pleural cavity.

* Note that invagination of the pleural sac by the lung takes place during intra-uterine life.

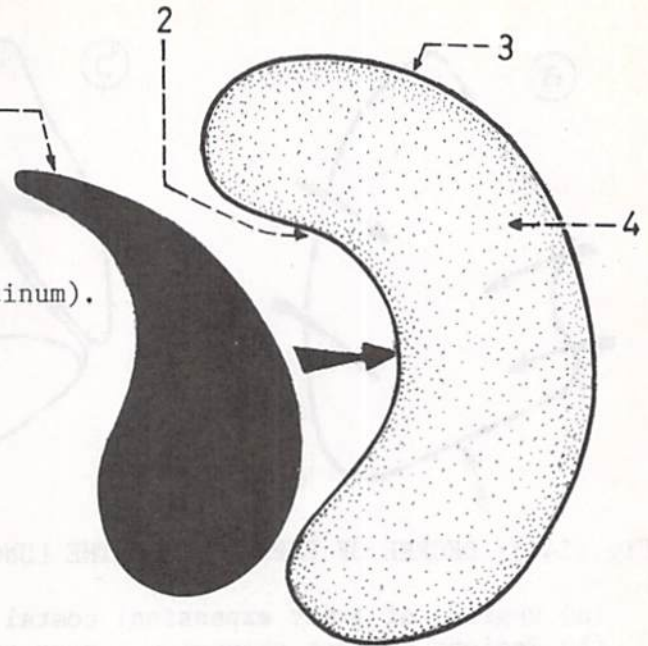


Fig.(248): PARIETAL AND PULMONARY LAYERS OF THE PLEURA

The parietal and pulmonary layers of the pleura are continuous together around the root of the lung which is the site where invagination of the pleural sac takes place.

1. site of continuity between the parietal and pulmonary layers of the pleura.
2. site of the root of the lung.
3. parietal layer of pleura covering the mediastinum.
4. pulmonary (visceral) layer of pleura covering the lung.
5. parietal layer of pleura lining the chest wall.
6. pleural cavity (between the parietal and pulmonary layers).
7. lung.

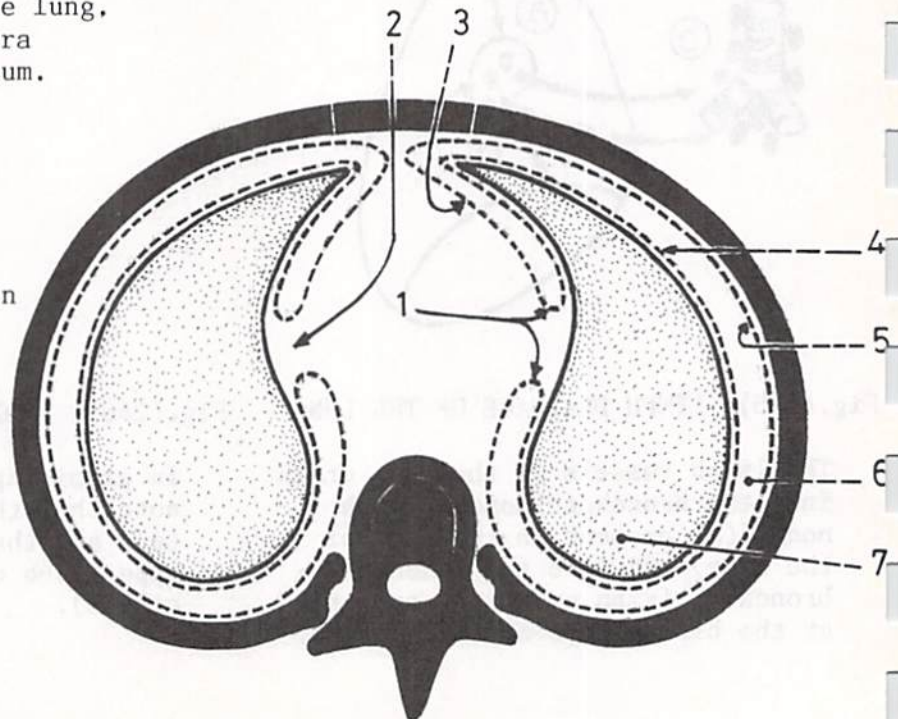


Fig.(249): PARTS OF THE PARIETAL PLEURA

The parietal pleura is divided into 4 parts: costal, diaphragmatic, mediastinal and cervical.

1. cervical pleura (dome of the pleura): covers the apex of the lung.
2. mediastinal pleura: covers the side of the mediastinum.
3. costal pleura: lines the chest wall.
4. chest wall.
5. costodiaphragmatic recess (between the costal and diaphragmatic pleurae).
6. diaphragmatic pleura: covers the upper surface of the diaphragm.
7. diaphragm.
8. mediastinum.

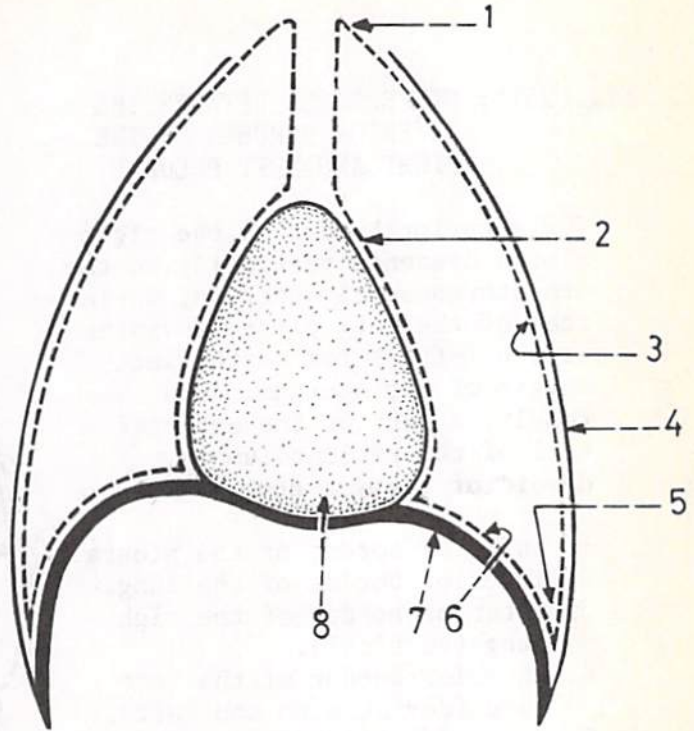
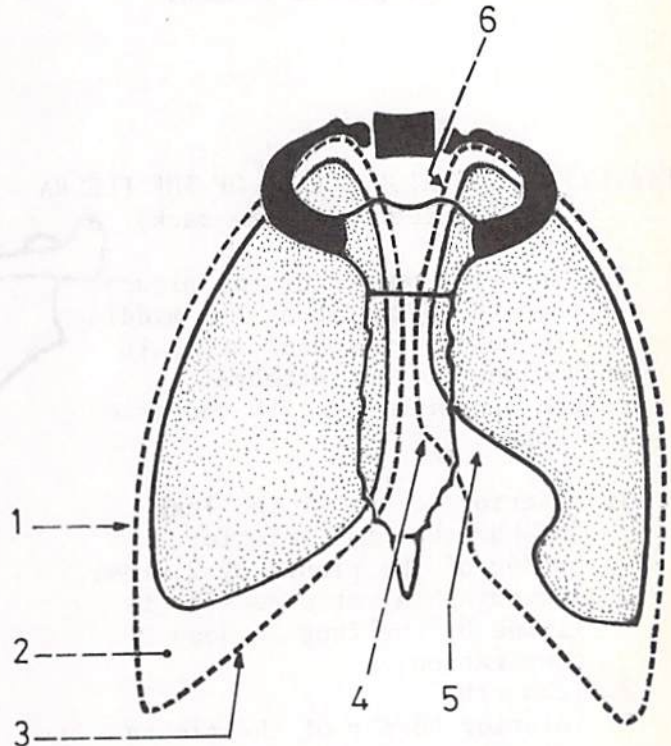


Fig.(250): BORDERS AND RECESSES OF THE PLEURA

1. posterior border of the pleura (corresponds to the posterior border of the lung).
2. costodiaphragmatic recess (a recess between the costal and diaphragmatic pleurae).
3. inferior border of the pleura (lower than the inferior border of the lung by 2 ribs).
4. anterior border of the left pleura (it deviates to the left opposite the 4th costal cartilage, then descends close to the sternum to the 6th costal cartilage).
5. costomediastinal recess (a recess between the costal and mediastinal pleurae).
6. cervical pleura.



* The costodiaphragmatic and costomediastinal recesses receive the expanded lung during deep inspiration.

Fig.(251): DIFFERENCES BETWEEN THE ANTERIOR BORDERS OF THE RIGHT AND LEFT PLEURAE

The anterior border of the right pleura descends vertically to the 6th sternocostal junction, while that of the left pleura deviates to the left as far as the left margin of the sternum. As a result, a part of the anterior wall of the pericardium is devoid of pleural covering.

1. inferior border of the pleura.
2. inferior border of the lung.
3. anterior border of the right lung (vertical).
4. anterior border of the left lung (deviates to the left).
5. area of pericardium not covered by pleura.
6. costodiaphragmatic recess.

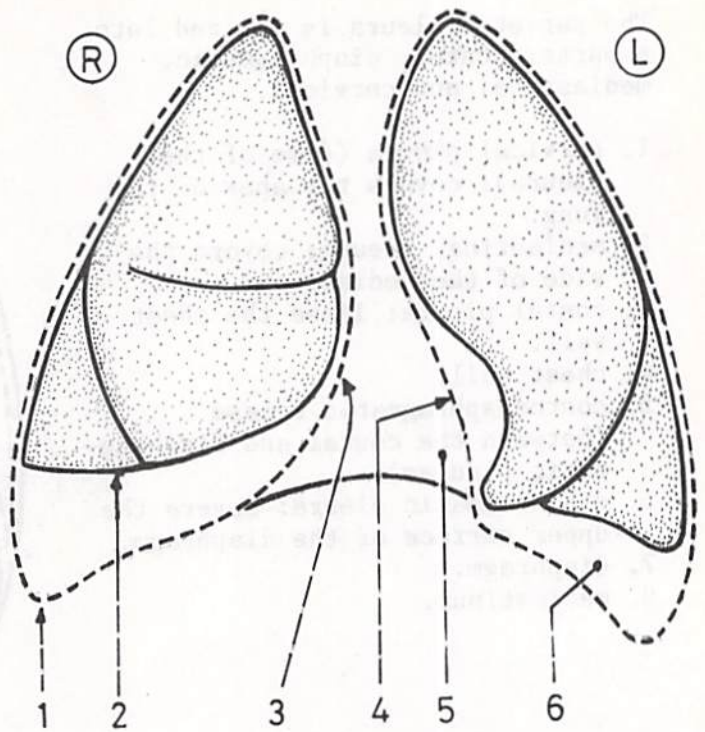


Fig.(252): INFERIOR BORDER OF THE PLEURA (as seen from the back)

The inferior border of the pleura crosses the 12th rib at its middle to lie below its medial part. It ends close to the vertebral column opposite the 12th thoracic vertebra.

1. inferior border of the lung (higher than the inferior border of the pleura by 2 ribs).
2. costodiaphragmatic recess (is filled by the lung in deep inspiration).
3. 12th rib.
4. inferior border of the pleura below the medial part of the 12th rib.

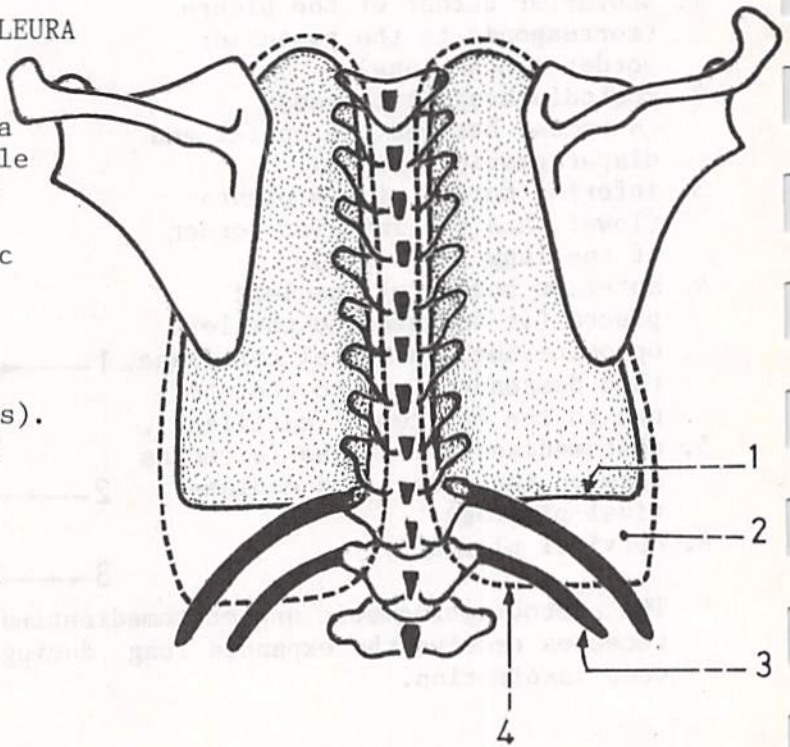


Fig.(253): RELATION OF THE LOWER BORDER OF THE PLEURA TO THE KIDNEY

The upper end of the kidney is separated from the lowermost part of the pleural cavity by the diaphragm. In operations on the kidney from the back, the presence of the inferior border of the pleura below the medial part of the 12th rib must be borne in mind, otherwise the pleural cavity be opened.

1. inferior border of the lung.
2. costodiaphragmatic recess of the pleura.
3. 11th rib.
4. 12th rib.
5. kidney.
6. inferior border of the pleura (crosses the last rib).

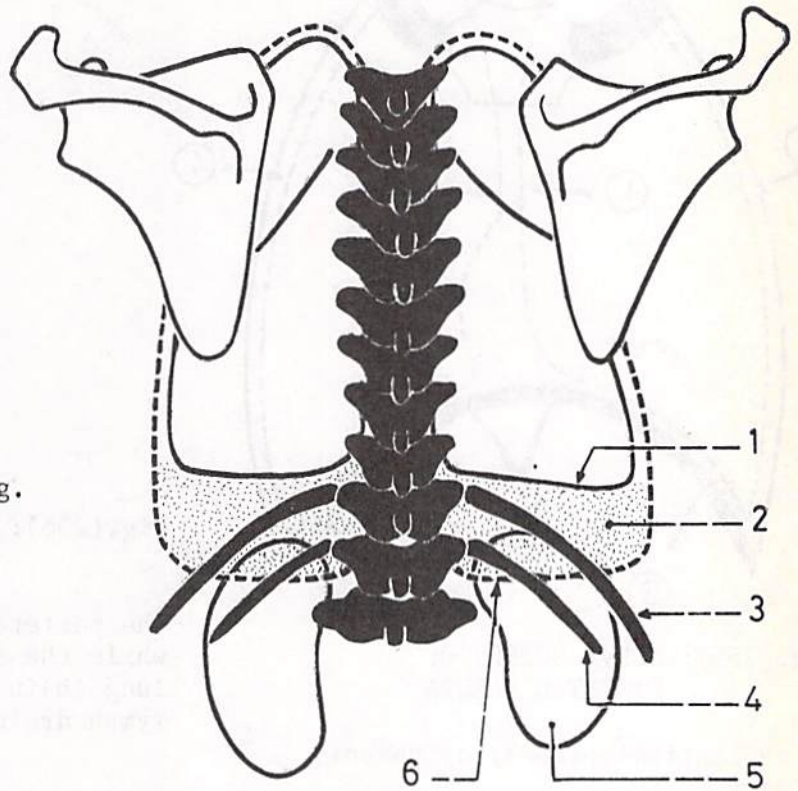
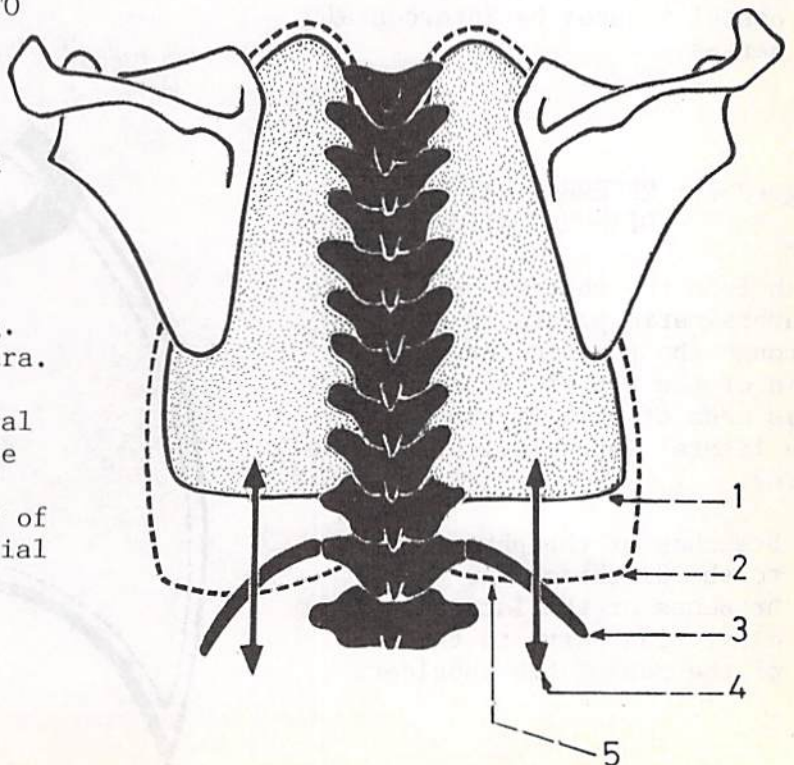


Fig.(254): RELATION OF THE INFERIOR BORDER OF THE PLEURA TO THE LATERAL MARGIN OF ERECTOR SPINAE MUSCLE

The inferior border of the pleura crosses the last rib at a point which corresponds to the lateral margin of the erector spinae muscle.

1. inferior border of the lung.
2. inferior border of the pleura.
3. last rib.
4. line representing the lateral margin of the erector spinae muscle.
5. part of the inferior border of the pleura below the medial part of the last rib.



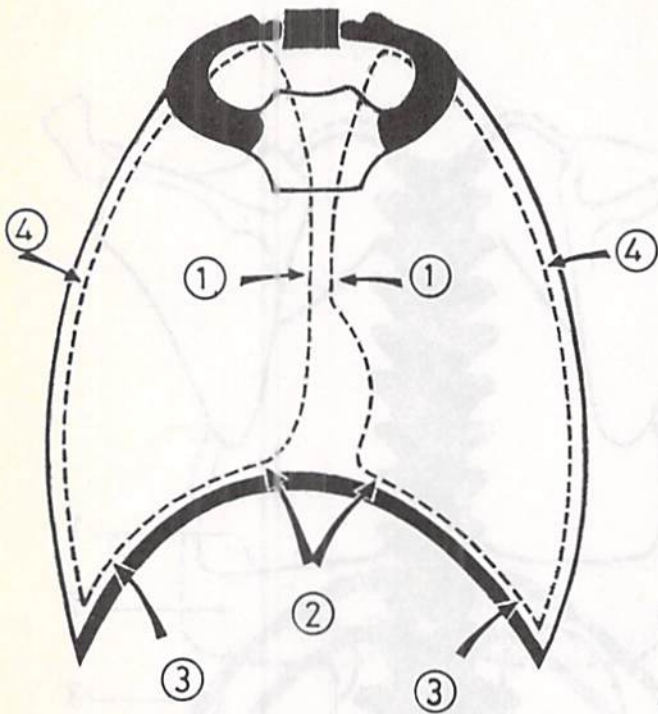


Fig.(255): NERVE SUPPLY OF PARIETAL PLEURA

1. mediastinal pleura: by phrenic nerve.
2. central part of diaphragmatic pleura: by phrenic nerve.
3. peripheral part of diaphragmatic pleura: by intercostal nerves.
4. costal pleura: by intercostal nerves.

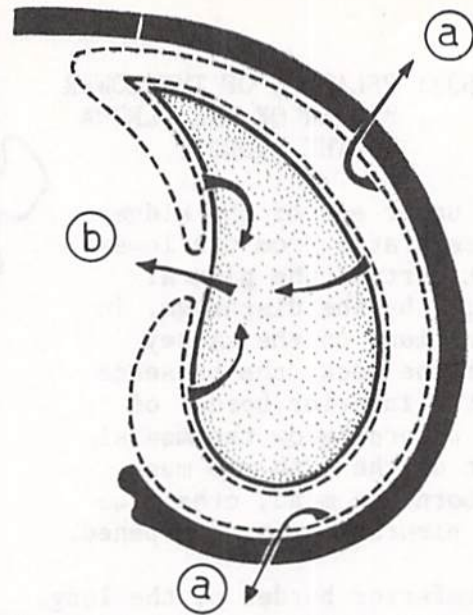


Fig.(256): BLOOD SUPPLY, NERVE SUPPLY AND LYMPH DRAINAGE OF PLEURA

The parietal pleura follows the chest wall(a) while the pulmonary pleura follows the lung (b) in its blood & nerve supply and lymph drainage.

Fig.(257): REFERRED PAIN FROM DIAPHRAGMATIC PLEURA

Pain from the central part of the diaphragmatic pleura is referred through the phrenic nerve to the skin of the top of the shoulder. This area of skin is supplied by the lateral supraclavicular nerve (C.4).

1. branches of the phrenic nerve to the diaphragmatic pleura.
2. branches of the lateral supraclavicular nerve to the skin of the top of the shoulder.

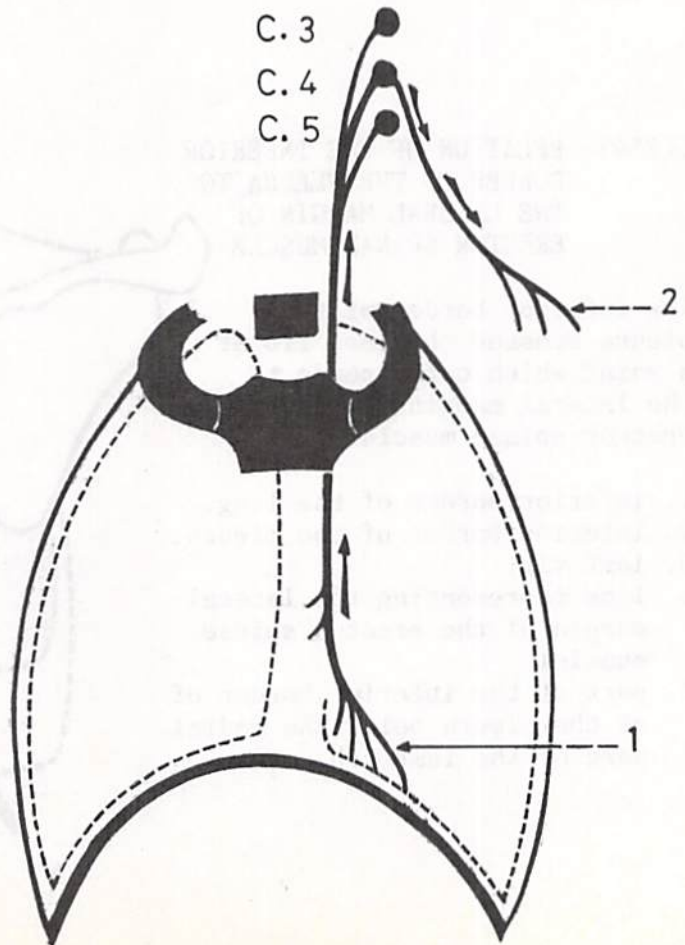
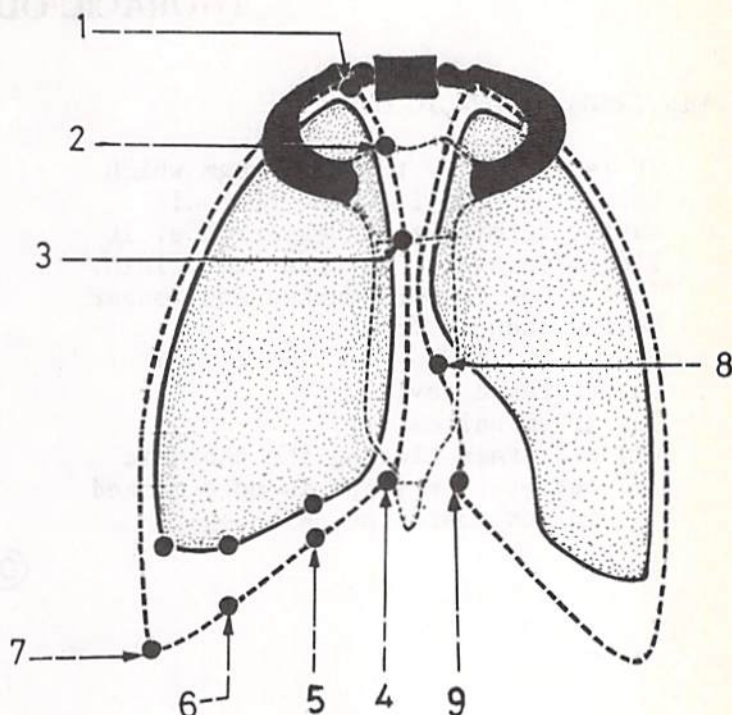


Fig.(258): SURFACE ANATOMY OF THE PLEURA

1. summit of cervical pleura:
3 cm above the medial 1/3
of the clavicle.
2. point at the sternoclavicular
joint.
3. point at the sternal angle
close to the median plane.
4. point at the right end of
xiphisternal junction.
5. point at the 8th rib in
the midclavicular line.
6. point at the 10th rib in
the midaxillary line.
7. point opposite the 12th
thoracic vertebra, close
to the vertebral column.
8. point at the left 4th
costal cartilage where the
anterior border of the left
pleura deviates to the left.
9. point at the 6th costal
cartilage, 5 - 20 mm from
the left margin of the sternum.

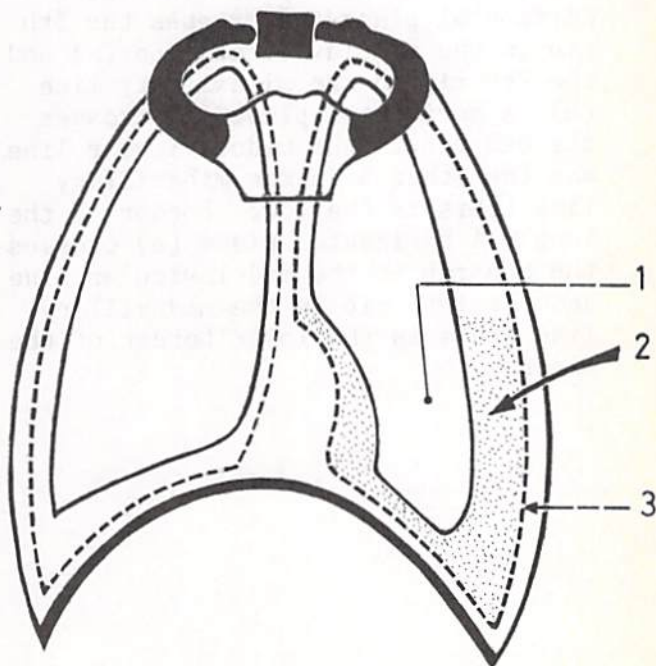


- * The cervical pleura extends
between the points 1 & 2.
The anterior border of right
pleura extends through the
points 2, 3 & 4. The inferior
border of the pleura extends
through the points 4, 5, 6 & 7.
The posterior border of the
pleura extends between the
points 7 & 1.
- * The anterior border of the left
pleura differs in having a deviation
to the left between the points 8 & 9.

Fig.(259): PLEURAL EFFUSION

It is the accumulation of fluid
inside the pleural cavity with 2ry
collapse of the lung.

1. collapsed lung.
2. pleural effusion.
3. parietal layer of the pleura.



THORACIC OUTLET

Fig.(260): THORACIC OUTLET

It is closed by the diaphragm which bulges upwards into the thoracic cavity forming a convex surface. It slopes downwards towards its origin. This slope is more marked and longer behind than in front.

- (a) thoracic cavity.
- (b) abdominal cavity.
- (c) diaphragm closing the thoracic outlet (its slope is more marked in its posterior part).

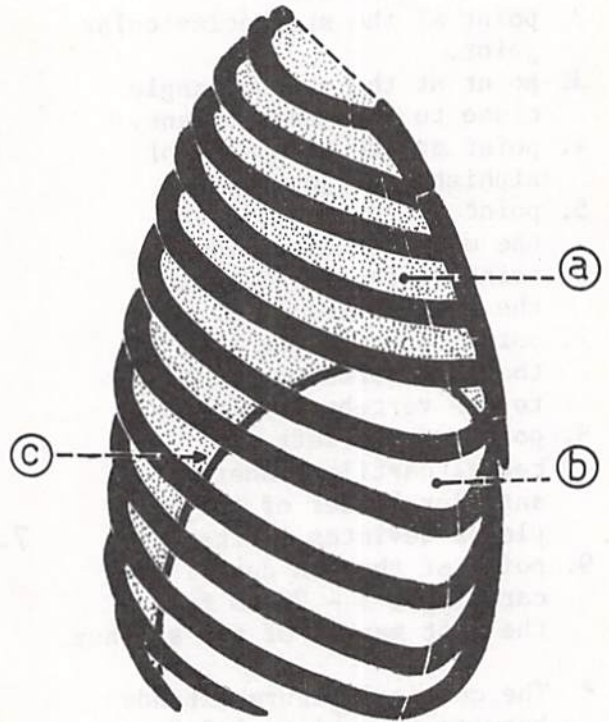


Fig.(261): LEVELS OF THE RIBS AT THE MIDCLAVICULAR AND MIDAXILLARY LINES

Due to the obliquity of the ribs a horizontal plane (c) crosses the 5th rib in the midclavicular line (a) and the 7th rib in the midaxillary line (b). A horizontal plane (d) crosses the 6th rib in the midclavicular line and the 8th rib in the midaxillary line (this is the lower border of the lung). A horizontal plane (e) crosses the 8th rib in the midclavicular line and the 10th rib in the midaxillary line (this is the lower border of the pleura).

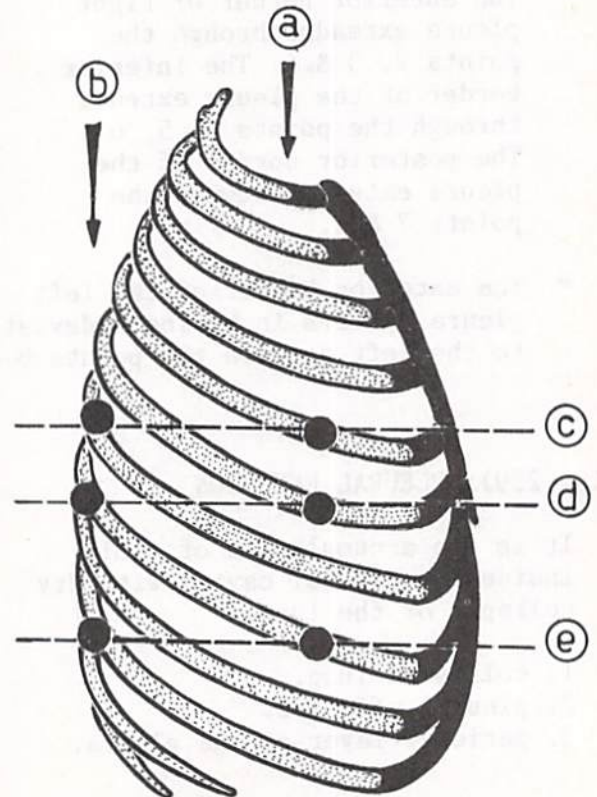
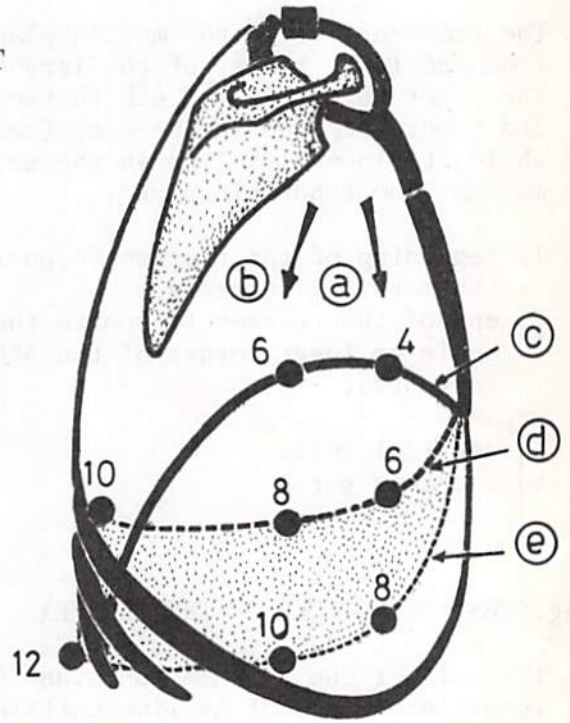


Fig.(262): LEVELS OF DIAPHRAGM, LUNG AND PLEURA ON THE SIDE OF THE CHEST

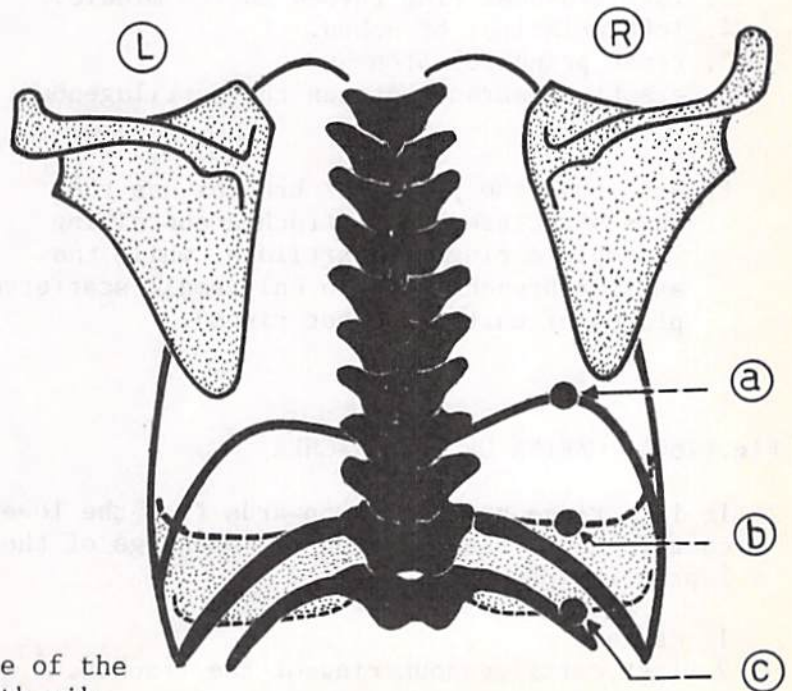
- (a) Midclavicular line.
- (b) Midaxillary line.
- (c) level of the diaphragm: crosses the 4th rib in the midclavicular line and the 6th rib in the midaxillary line.
- (d) Level of the lower border of the lung: crosses the 6th rib in the midclavicular line, 8th rib in the midaxillary line and 10th rib on the back.
- (e) Level of the lower border of the pleura: crosses the 8th rib in the midclavicular line, 10th rib in the midaxillary line and 12th rib on the back.



* Note that the higher level of the diaphragm is due to the fact that the summit of its convexity corresponds to the concavity of the base of the lung and not to its lower border.

Fig.(263): LEVELS OF DIAPHRAGM, LUNG AND PLEURA ON THE BACK

- (a) Level of the diaphragm: crosses the 8th rib in the plane of the medial border of the scapula.
- (b) Level of the lower border of the lung: crosses the 10th rib in the plane of the medial border of the scapula.
- (c) Level of the lower border of the pleura: crosses the 12th rib in the plane of the medial border of the scapula.



* Note that the inferior angle of the scapula lies opposite the 7th rib.

TRACHEA

Fig.(264): POSITION OF THE TRACHEA

The trachea lies in the median plane extending from the lower border of the larynx down to the lower border of the 4th thoracic vertebra. Its upper 1/2 lies in the neck (cervical part), while its lower 1/2 lies in the superior mediastinum (thoracic part).

1. beginning of the trachea (opposite the 6th cervical vertebra).
2. end of the trachea (opposite the sternal angle or lower border of the 4th thoracic vertebra).

(a) cervical part.
(b) thoracic part.

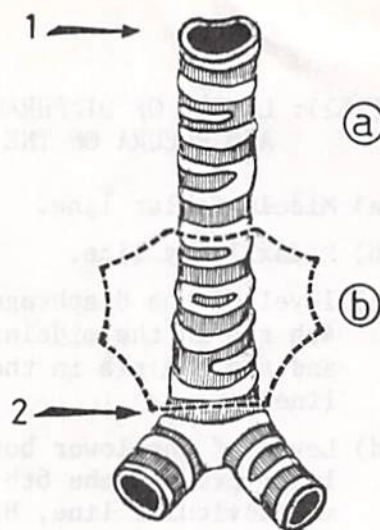


Fig.(265): STRUCTURE OF THE TRACHEA

The wall of the trachea contains 16 - 20 incomplete rings of hyaline cartilage which are connected together by elastic membranes and unstriated muscle fibres. The cartilagenous rings are incomplete posteriorly where they are replaced by unstriated muscle fibres.

1. unstriated muscle fibres in the posterior part of the trachea (flat).
2. curved tracheal ring (hyaline cartilage).
3. last tracheal ring (broad in its middle).
4. left principal bronchus.
5. right principal bronchus.
6. elastic membrane between the cartilagenous rings.

* Note that the principal bronchi has the same structure as the trachea containing incomplete rings of cartilage, while the smaller bronchi contain only small scattered plates of cartilage (not rings).

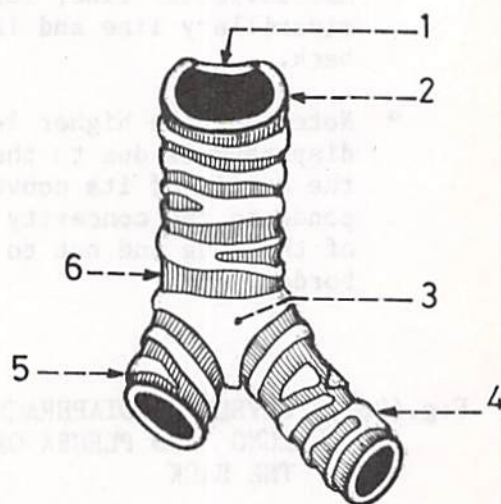
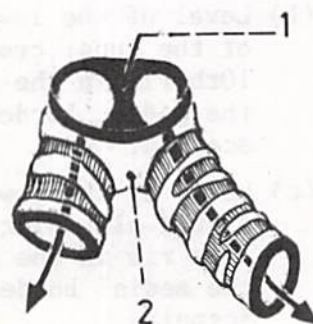


Fig.(266): CARINA OF THE TRACHEA

It is a ridge projecting upwards from the lower cartilagenous ring between the openings of the 2 principal bronchi.

1. carina.
2. last cartilagenous ring of the trachea.



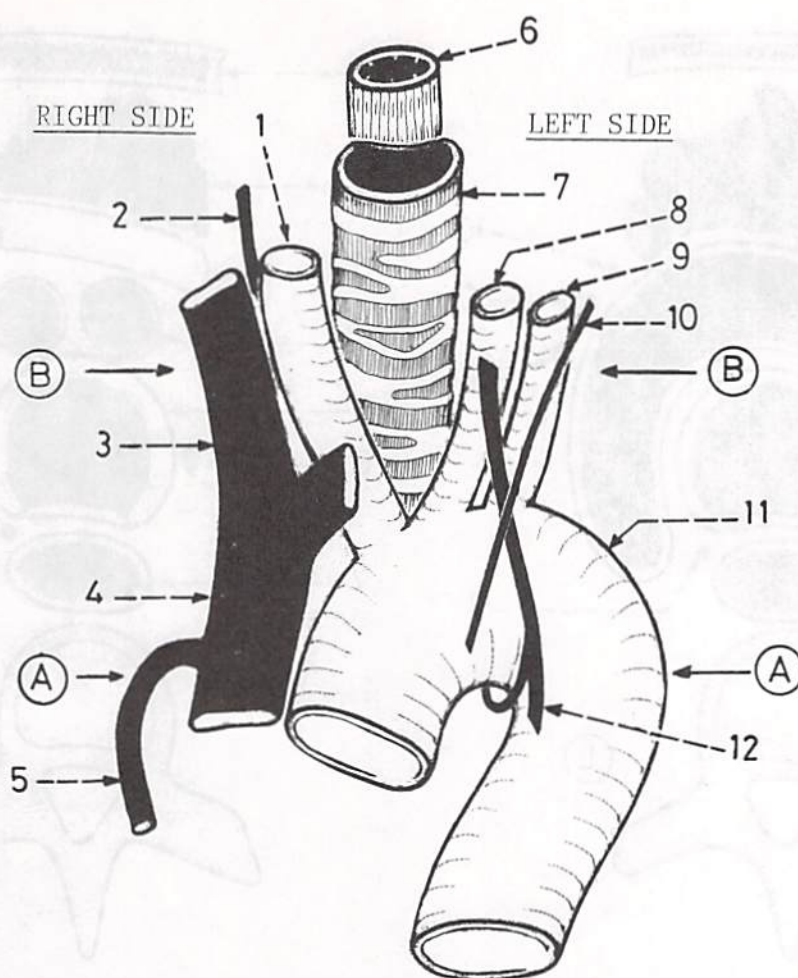


Fig.(267): STRUCTURES RELATED TO THE TRACHEA

The thoracic part of the trachea lies in the superior mediastinum and is directly related to the following structures: arch of the aorta and its 3 branches, superior vena cava and its tributaries, oesophagus and nerves (left recurrent laryngeal and right vagus).

1. brachiocephalic artery.
2. right vagus nerve.
3. right brachiocephalic vein.
4. superior vena cava.
5. azygos vein.
6. oesophagus.
7. trachea.
8. left common carotid artery.
9. left subclavian artery.
10. left phrenic nerve.
11. arch of the aorta.
12. left vagus nerve.

Level A - A : this is a lower horizontal level passing through the arch of the aorta on the left side and the arch of the azygos vein on the right side.

Level B - B : this is a higher horizontal level passing through the branches of the arch of the aorta and the brachiocephalic veins.

* These are the levels of figures: 268, 269, 270, 271, 272 and 273.

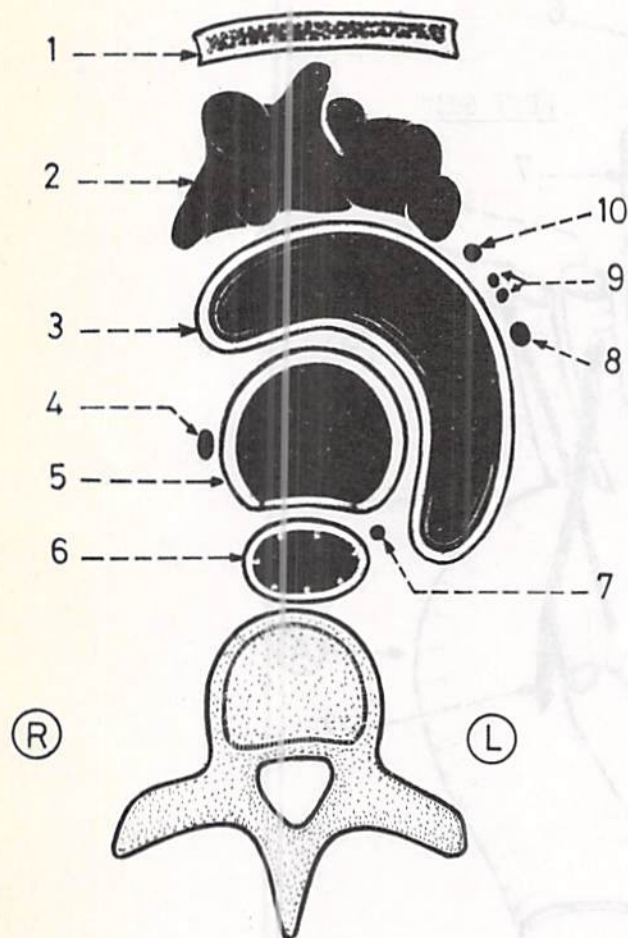


Fig.(268): ANTERIOR RELATIONS OF THE TRACHEA
(level of the arch of the aorta)

This is a transverse section in the trachea and its relations at the level A - A of fig.(267).

1. sternum.
2. thymus gland.
3. arch of the aorta.
4. right vagus nerve (on the right side).
5. trachea.
6. oesophagus (behind).
7. left recurrent laryngeal nerve.
8. left vagus nerve.
9. cardiac nerves.
10. left phrenic nerve.

* The anterior relations at this level are the arch of the aorta and thymus gland.

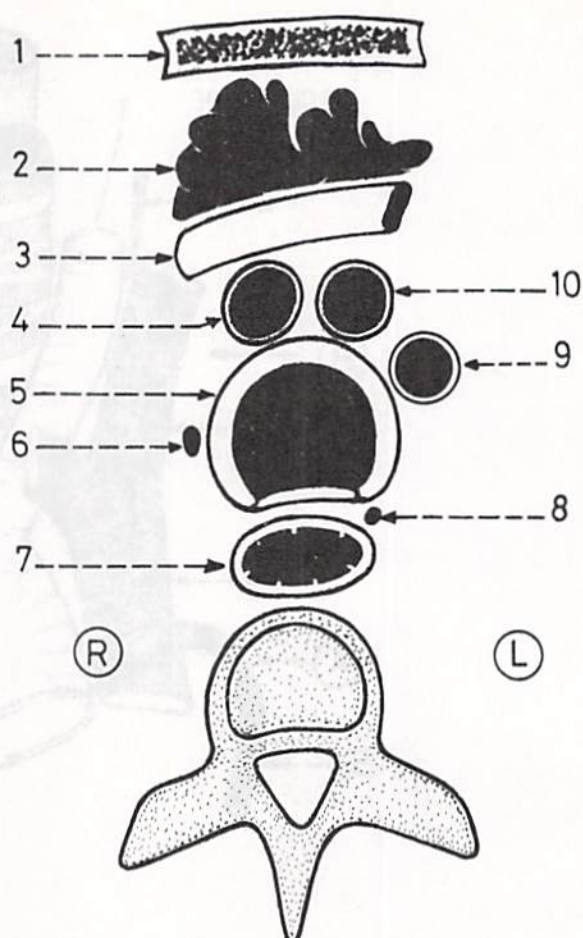


Fig.(269): ANTERIOR RELATIONS OF THE TRACHEA
(level above the arch of the aorta)

This is a transverse section in the trachea and its relations at the level B - B of fig.(267).

1. sternum.
2. thymus gland.
3. left brachiocephalic vein.
4. origin of brachiocephalic artery (in front).
5. trachea.
6. right vagus nerve.
7. oesophagus.
8. left recurrent laryngeal nerve.
9. origin of left subclavian artery (to the left).
10. origin of left common carotid artery (in front).

* The anterior relations at this level are the origins of two of the branches of the arch of the aorta, left brachiocephalic vein and thymus gland.

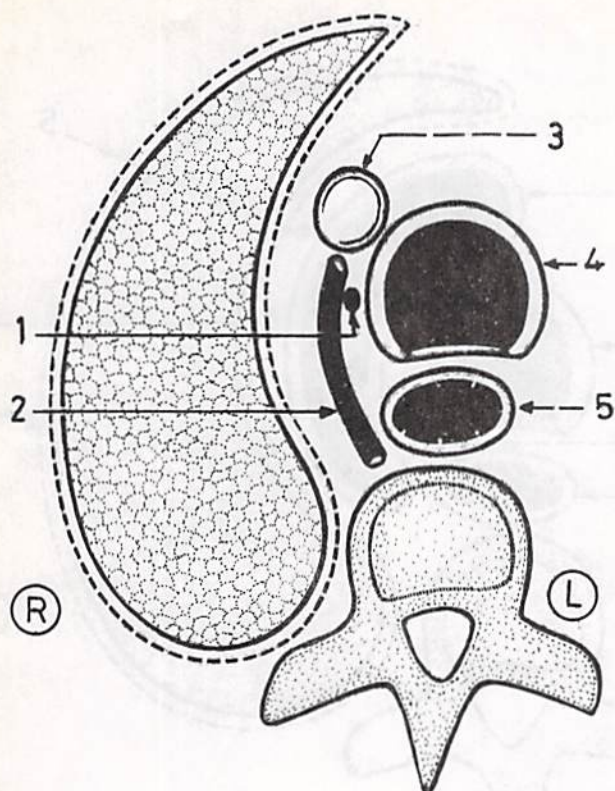


Fig.(270): RIGHT SIDE RELATIONS
OF THE TRACHEA
(level of the arch of
the azygos vein)

This is a transverse section in the trachea and its relations at the level A - A of fig.(267).

1. right vagus nerve (on the right side).
2. arch of azygos vein (directed forwards on the right side of the trachea).
3. superior vena cava.
4. trachea.
5. oesophagus (behind the trachea).

* The right relations at this level are the arch of the azygos vein, superior vena cava and right vagus nerve.

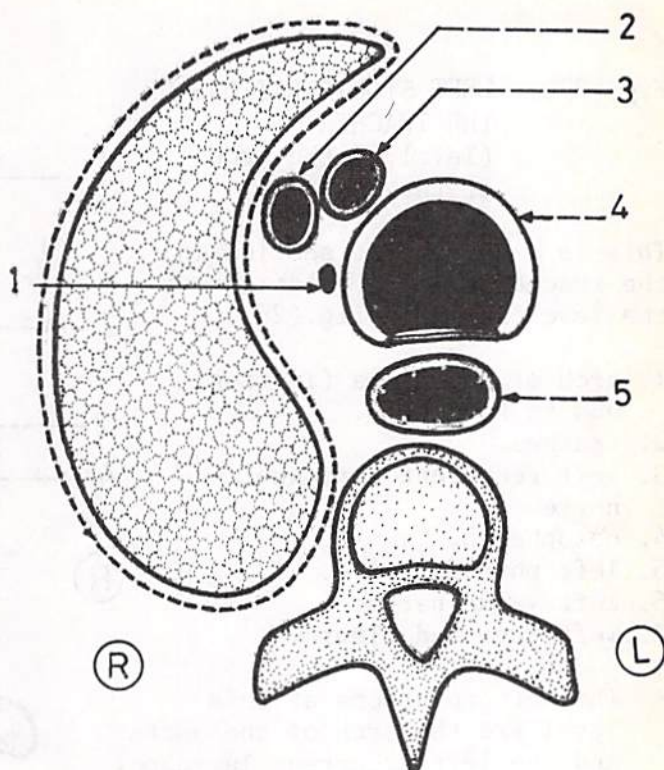


Fig.(271): RIGHT SIDE RELATIONS
OF THE TRACHEA
(level above the arch of
the azygos vein)

This is a transverse section in the trachea and its relations at the level B - B of fig.(267).

1. right vagus nerve.
2. right brachiocephalic vein.
3. upper part of brachiocephalic artery.
4. trachea.
5. oesophagus.

* The right relations at this level are the right vagus nerve, right brachiocephalic vein and upper part of the brachiocephalic artery.

Fig.(272): LEFT SIDE RELATIONS OF THE TRACHEA
(level of the arch of the aorta)

This is a transverse section in the trachea and its relations at the level A - A of fig.(267).

1. arch of the aorta (in front and to the left).
2. trachea.
3. left recurrent laryngeal nerve.
4. oesophagus.
5. left phrenic nerve.
6. left vagus nerve.
7. left lung and pleura.

* The left relations at this level are the arch of the aorta and the left recurrent laryngeal nerve which runs in the groove between the trachea and oesophagus.

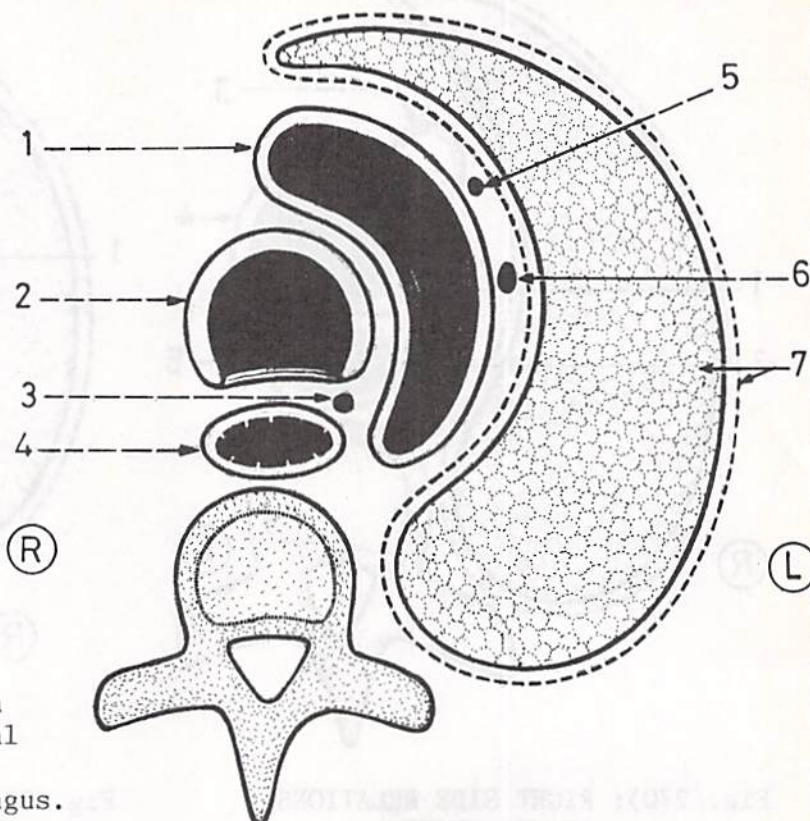
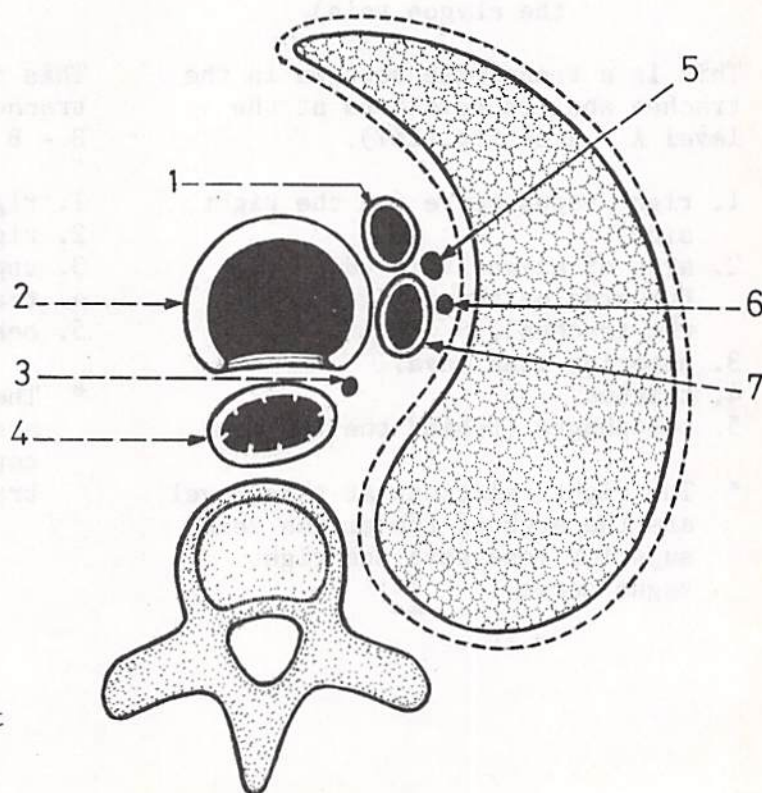


Fig.(273): LEFT SIDE RELATIONS OF THE TRACHEA
(level above the arch of the aorta)

This is a transverse section in the trachea and its relations at the level B - B of fig.(267).

1. left common carotid artery (upper part).
2. trachea.
3. left recurrent laryngeal nerve.
4. oesophagus.
5. left vagus nerve.
6. left phrenic nerve.
7. left subclavian artery.

* The left relations at this level are the left subclavian artery, upper part of the left common carotid artery and left recurrent laryngeal nerve.



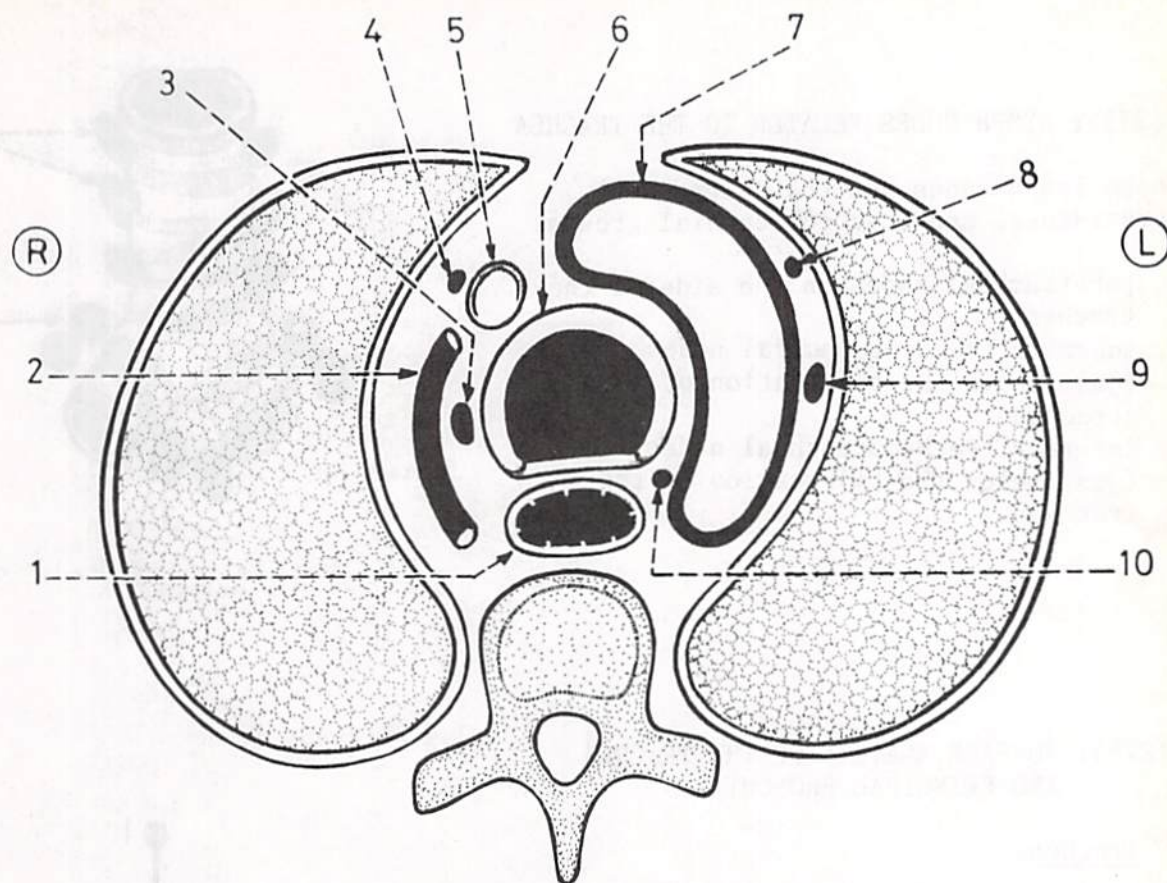


Fig.(274): STRUCTURES RELATED TO THE TRACHEA AT THE LEVEL OF THE ARCH OF THE AORTA (T.S.)

1. oesophagus (posterior).
2. arch of azygos vein (on the right side).
3. right vagus nerve (on the right side).
4. right phrenic nerve (on the right side of superior vena cava).
5. superior vena cava (on the right side).
6. trachea (in the centre of the superior mediastinum).
7. arch of the aorta (in front and on the left side of the trachea).
8. left phrenic nerve (on the left side of the arch of the aorta).
9. left vagus nerve (on the left side of the arch of the aorta).
10. left recurrent laryngeal nerve (on the left side of the trachea, in the groove between it and the oesophagus).

* The contents of the superior mediastinum surround the trachea from all aspects (in front, behind and on each side) and thus, the trachea can be considered as the "key" to the superior mediastinum.

* Note that the upper part of the trachea differs from its lower part in the related structures. The lower part of the trachea is mainly related to 2 arches (arch of the aorta and arch of the azygos vein).

Fig.(275): LYMPH NODES RELATED TO THE TRACHEA

These lymph nodes are the pretracheal, paratracheal and tracheobronchial groups.

- 1. paratracheal nodes(on the side of the trachea).
- 2. superior tracheobronchial nodes (just above the bifurcation of the trachea).
- 3. inferior tracheobronchial nodes (just below the bifurcation of the trachea).

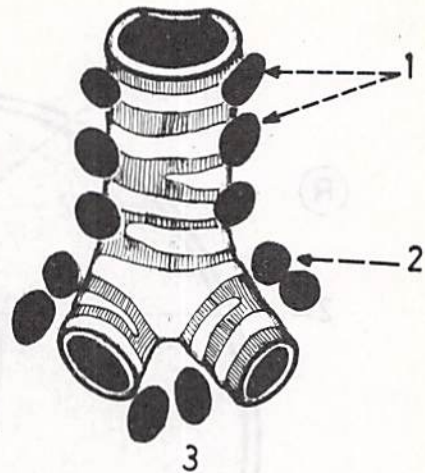


Fig.(276): SURFACE ANATOMY OF THE TRACHEA AND PRINCIPAL BRONCHI

* Trachea:

It is represented by a vertical line drawn in the midline from the lower border of the larynx (point 1) down to the middle of the sternal angle (point 2).

* Right principal bronchus:

It is represented by an oblique line ($2\frac{1}{2}$ cm long) drawn from the middle of the sternal angle (point 2) to the sternal end of the right 3rd costal cartilage (point 3).

* Left principal bronchus:

It is represented by a more horizontal line (5 cm long) drawn from the middle of the sternal angle (point 2) to the left 3rd costal cartilage (point 4).

* Note that the upper end of the trachea is opposite the 6th cervical vertebra.

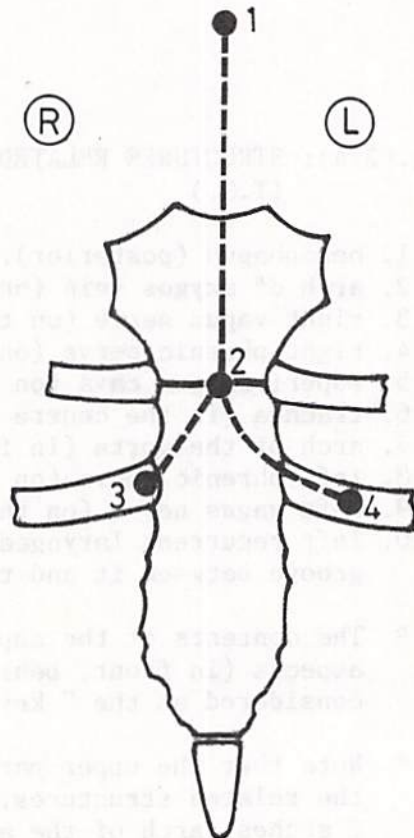


Fig.(277): ARTERIAL SUPPLY OF THE TRACHEA

The cervical part of the trachea is supplied by the inferior thyroid arteries (1), while the thoracic part of the trachea is supplied by the bronchial arteries (2).

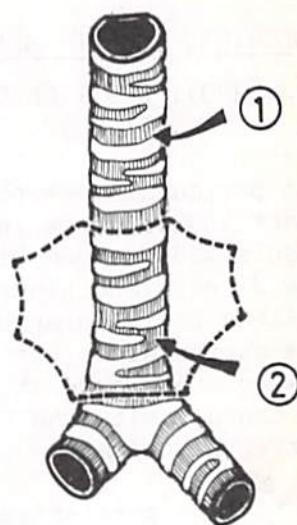


Fig.(278): NERVE SUPPLY OF THE TRACHEA

The trachea is supplied by sympathetic and parasympathetic fibres.

1. branches from the vagus nerve.
2. branches from the sympathetic trunk.
3. branches from the recurrent laryngeal nerve.

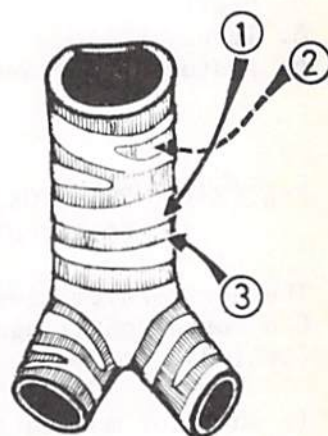
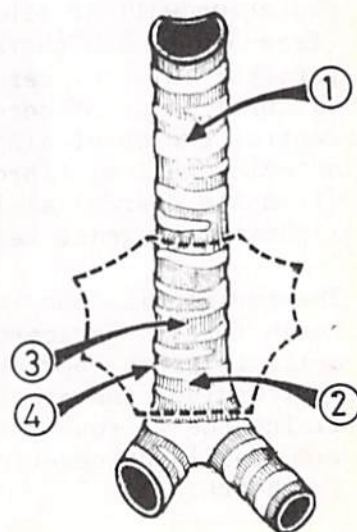


Fig.(279): COMPRESSION OF THE TRACHEA

The trachea may be compressed in the neck by an enlarged thyroid gland (1), or in the superior mediastinum by an aneurysm of the arch of the aorta (2), by an enlarged thymus gland (3) or by an enlarged lymph node (4).



PERICARDIUM

POSITION, SHAPE AND RELATIONS

Fig.(280): POSITION OF THE PERICARDIUM
(T.S.)

The pericardium (with the heart inside) lies in the middle mediastinum with the 2 lungs and pleurae related to it anteriorly and on the sides, but not posteriorly where it comes in contact with the vertebral column.

1. fibrous pericardium.
2. anterior mediastinum.
3. the 2 layers of the serous pericardium.
4. heart.
5. lung.
6. posterior mediastinum.

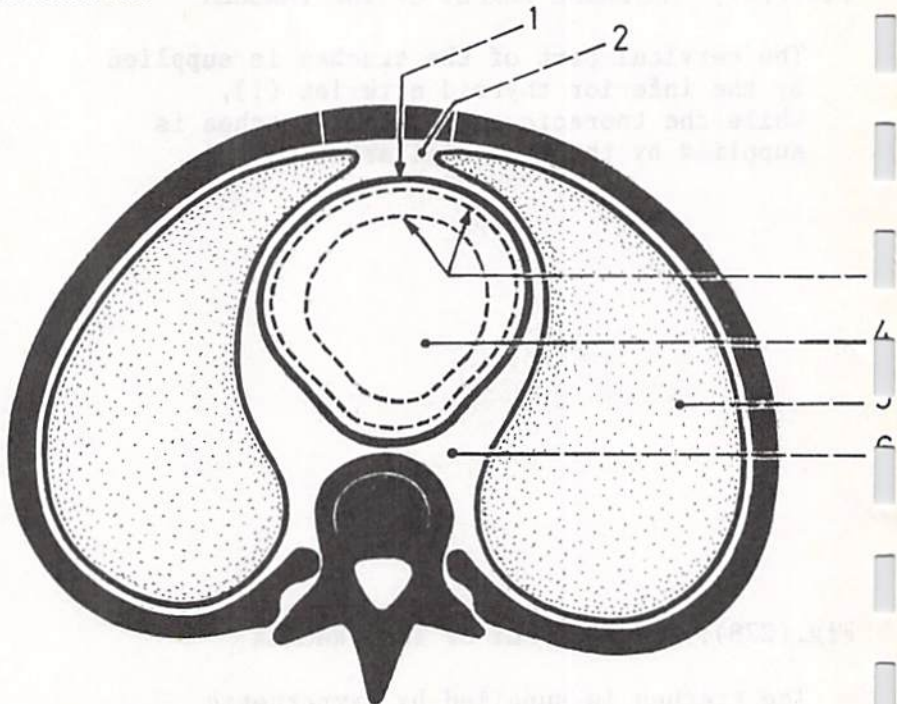


Fig.(281): POSITION OF THE PERICARDIUM
(sagittal section)

The pericardium lies in the middle mediastinum extending from the 2nd to the 6th costal cartilage (in front) and from the 5th to the 8th thoracic vertebra (behind).

1. superior mediastinum (above the level of the sternal angle).
2. site of invagination of the serous pericardium by the heart.
3. posterior wall of fibrous pericardium (from 5th to 8th thoracic vertebrae).
4. parietal layer of serous pericardium.
5. visceral layer of serous pericardium.
6. central tendon of diaphragm.
7. anterior wall of fibrous pericardium (from the sternal angle above to the xiphisternal joint below).

* The pericardium consists of an outer tough fibrous pericardium and an inner delicate serous pericardium. The serous pericardium consists of a parietal layer lining the fibrous pericardium and a visceral layer covering the surface of the heart.

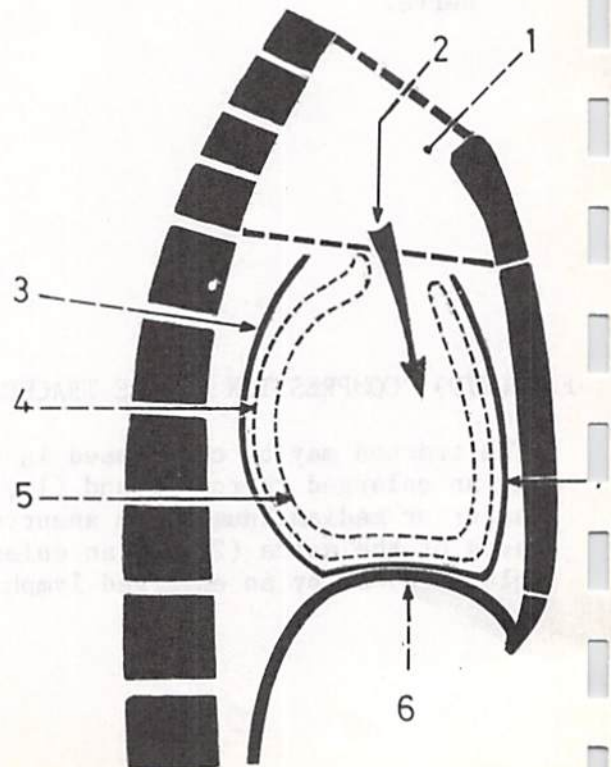


Fig.(282): INVAGINATION OF THE SEROUS SAC OF PERICARDIUM BY THE HEART

The serous sac of pericardium is invaginated (in the foetus) from above and behind by the heart, and as a result it becomes formed of a parietal layer and a visceral layer.

1. fibrous pericardium (outer tough layer).
2. site of invagination of the serous sac.
3. serous sac of pericardium.
4. cavity of pericardium.
5. diaphragm.

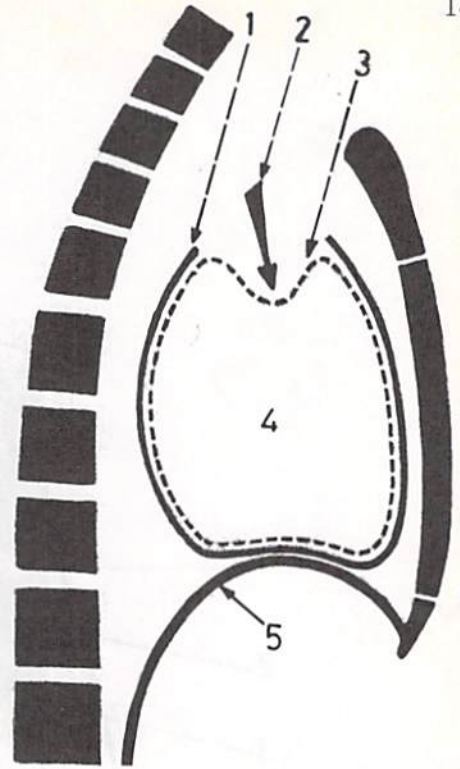
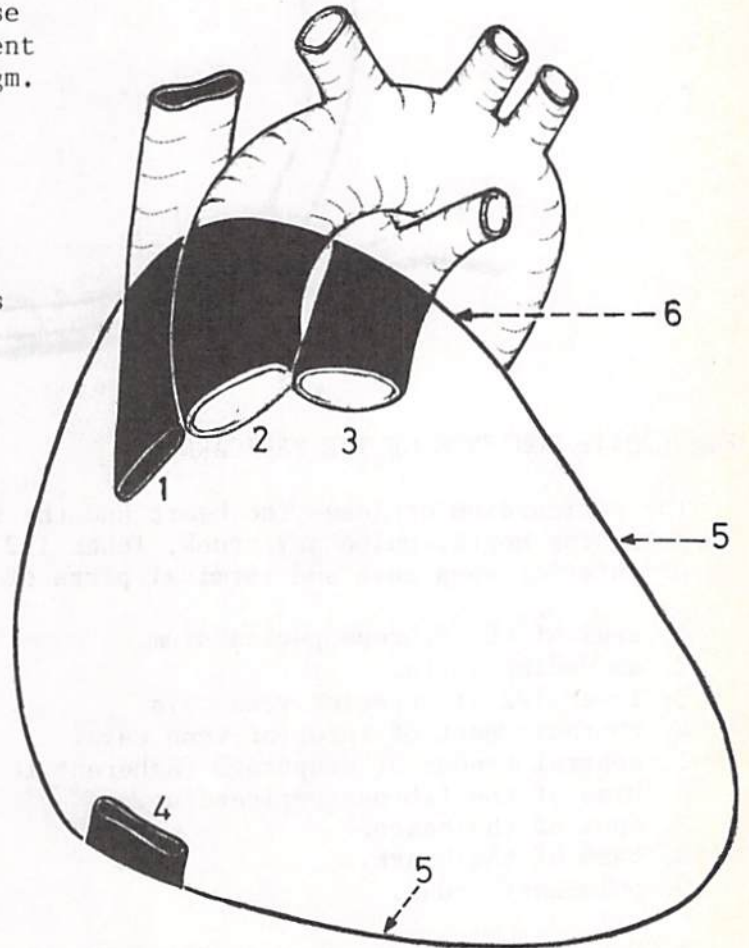


Fig.(283): SHAPE OF THE PERICARDIUM

The pericardium is conical in shape having an apex directed upwards where it is adherent to the walls of the great vessels of the heart, and a base directed downwards where it is adherent to the central tendon of the diaphragm.

1. superior vena cava.
2. ascending aorta.
3. pulmonary trunk.
4. inferior vena cava.
5. base of the pericardium.
6. apex of the pericardium (surrounds the great vessels of the heart).



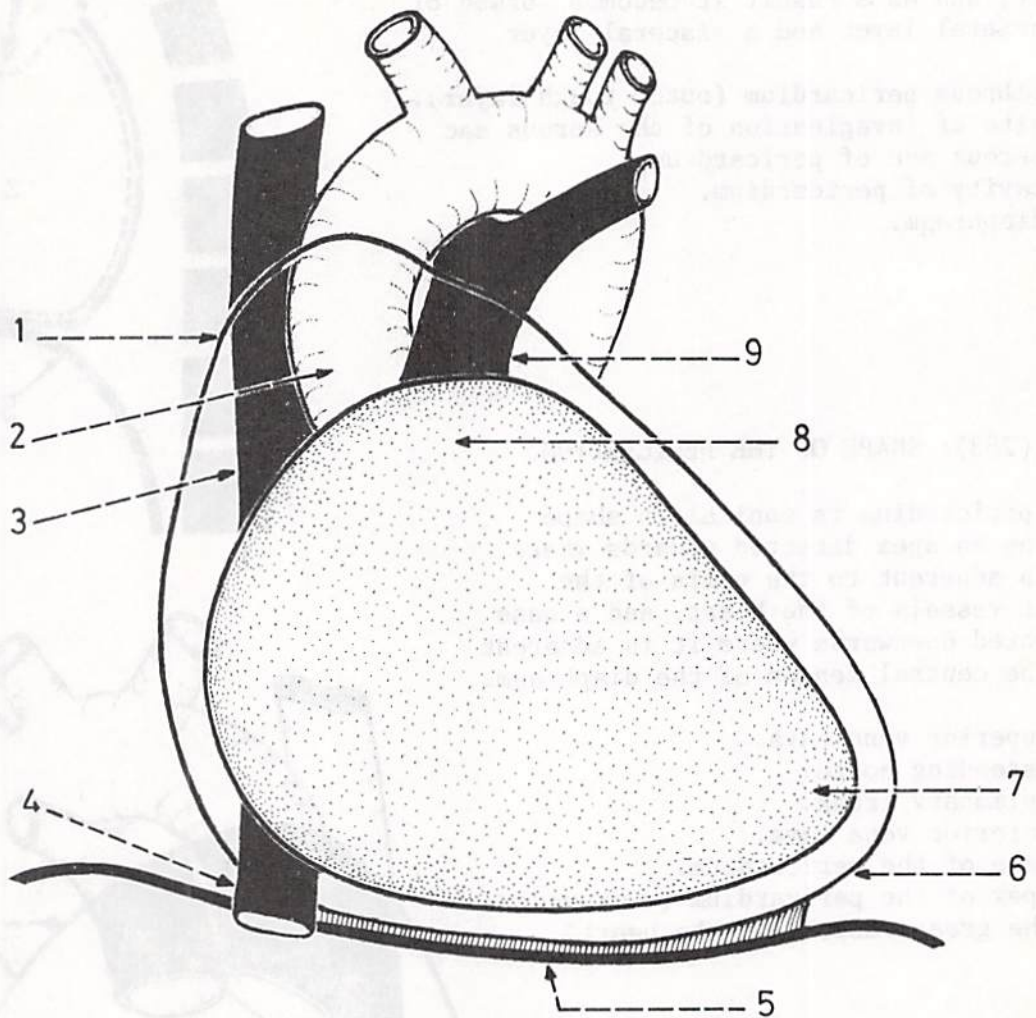


Fig.(284): CONTENTS OF THE PERICARDIUM

The pericardium encloses the heart and the roots of the great vessels which are: ascending aorta, pulmonary trunk, lower 1/2 of superior vena cava, thoracic part of inferior vena cava and terminal parts of the 4 pulmonary veins.

1. apex of the fibrous pericardium.
2. ascending aorta.
3. lower 1/2 of superior vena cava.
4. thoracic part of inferior vena cava.
5. central tendon of diaphragm (adherent to the base of pericardium).
6. base of the fibrous pericardium.
7. apex of the heart.
8. base of the heart.
9. pulmonary trunk.

* Note that the base of the pericardium is directed downwards and its apex directed upwards, while the base of the heart is directed upwards and backwards and its apex directed downwards and forwards.

Fig.(285): BARE AREA OF THE PERICARDIUM

The anterior wall of the pericardium is covered by the 2 lungs and pleurae except at an area behind the left $1/2$ of the lower part of the sternum and adjoining left costal cartilages from 4 to 6; this area is called the bare area of pericardium.

1. the part of the bare area of pericardium behind the sternum (not covered by either lung or pleura).
2. the part of the bare area of pericardium behind the left costal cartilages from 4 to 6 (not covered by lung but still covered by pleura).
3. left pleura.
4. left lung.

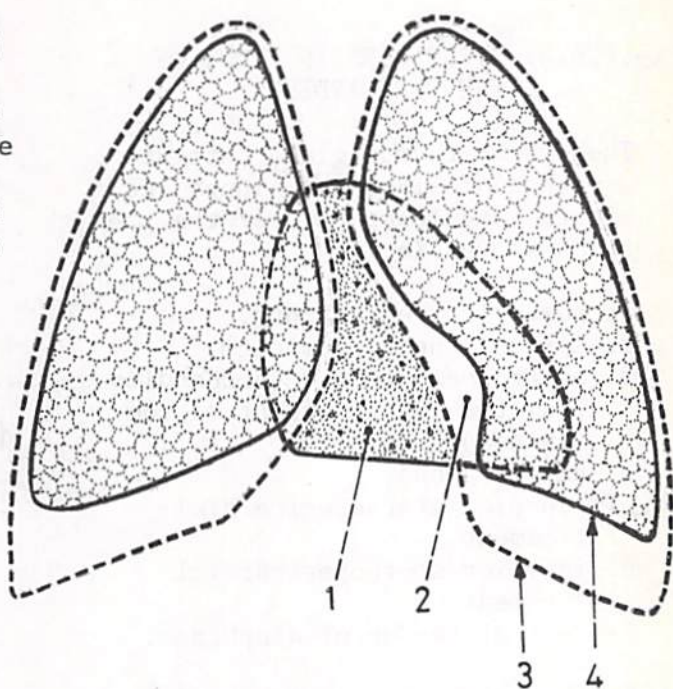


Fig.(286): PARACENTESIS OF THE PERICARDIUM

It is the drainage of fluid accumulated inside the pericardial cavity by a needle. It may be performed in the 5th or 6th intercostal space very close to the sternum or in the left costo-xiphoid angle. At these 2 sites there is no risk of puncturing the lung or the pleura.

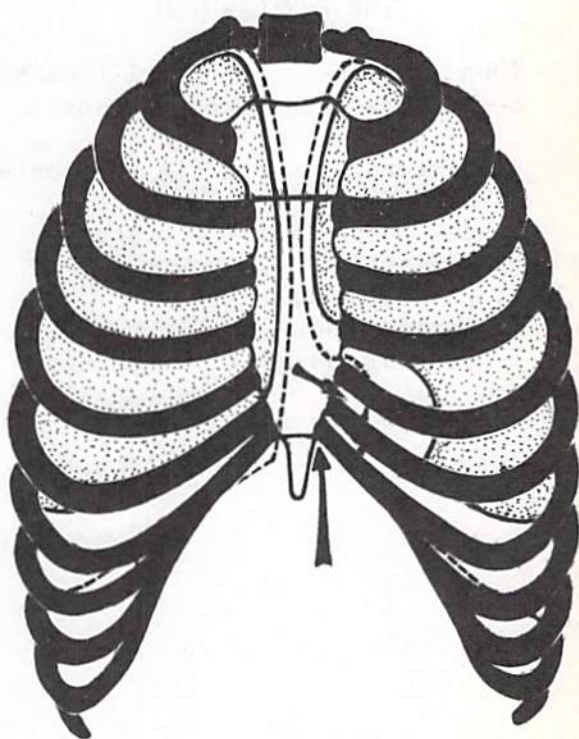


Fig.(287): STRUCTURES IN FRONT OF THE PERICARDIUM

These are: thymus gland, sterno-pericardial ligaments, lungs and pleurae and lower part of the pre-tracheal fascia.

1. posterior mediastinum.
2. apex of the pericardium.
3. pretracheal fascia (descending from the neck in front of the trachea).
4. thymus gland.
5. superior sternopericardial ligament.
6. inferior sternopericardial ligament.
7. central tendon of diaphragm.

* The structures in front of the pericardium lie in the anterior mediastinum.

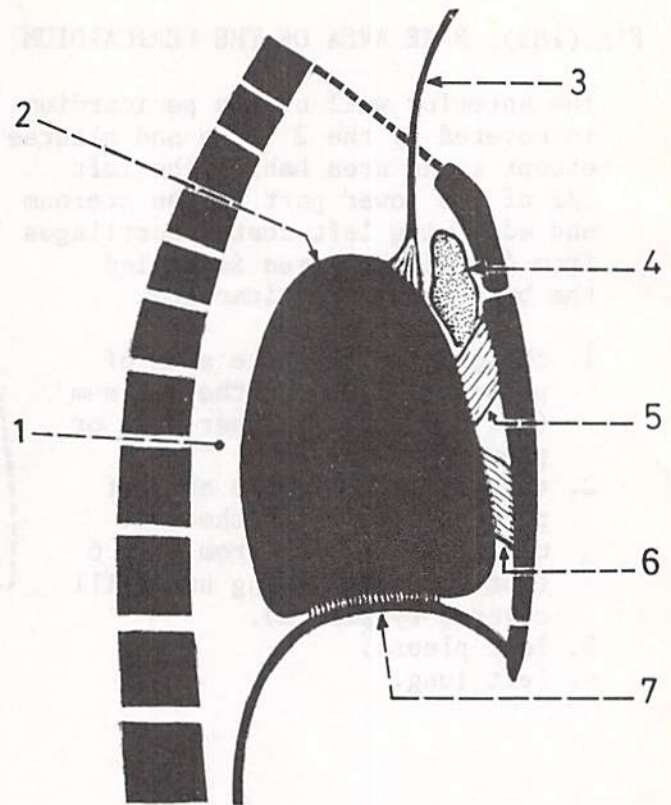
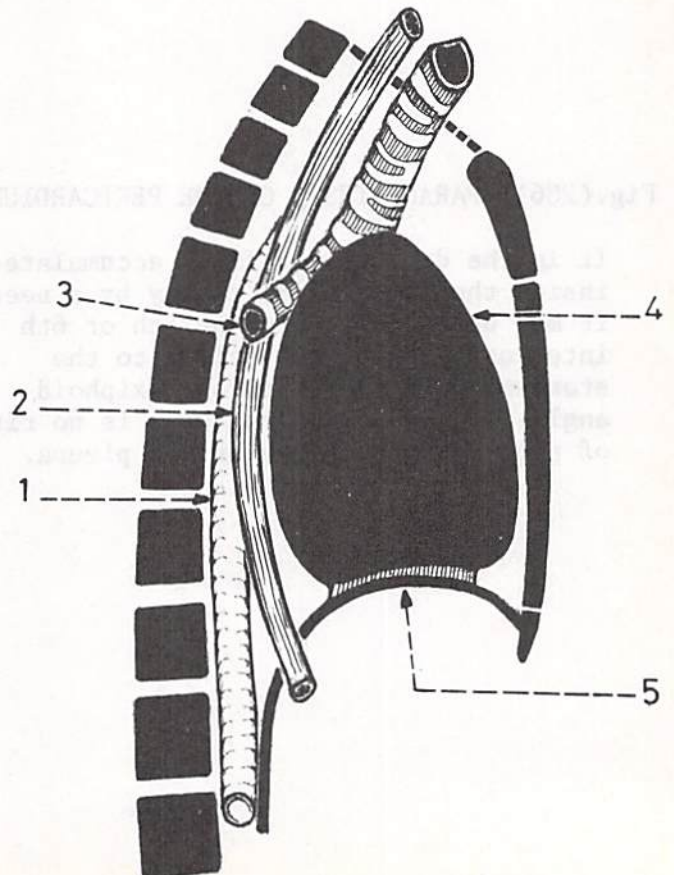


Fig.(288): STRUCTURES BEHIND THE PERICARDIUM

These are the 2 principal bronchi, oesophagus and descending aorta.

1. descending aorta (in the posterior mediastinum).
2. oesophagus (in the posterior mediastinum).
3. principal bronchus.
4. pericardium.
5. central tendon of diaphragm.



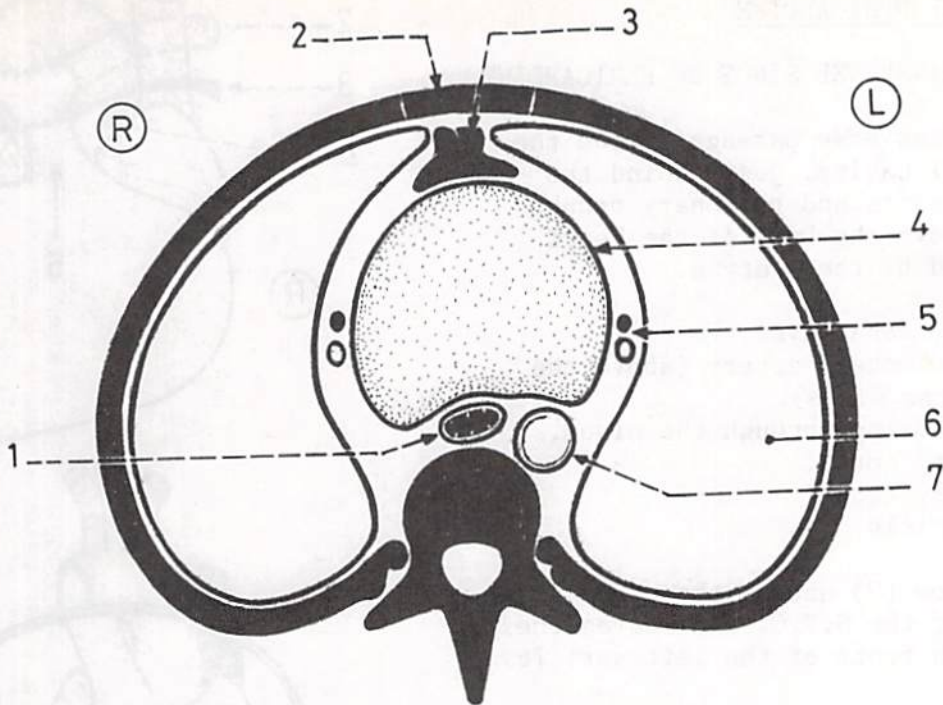


Fig.(289): STRUCTURES ON EACH SIDE OF THE PERICARDIUM (T.S.)

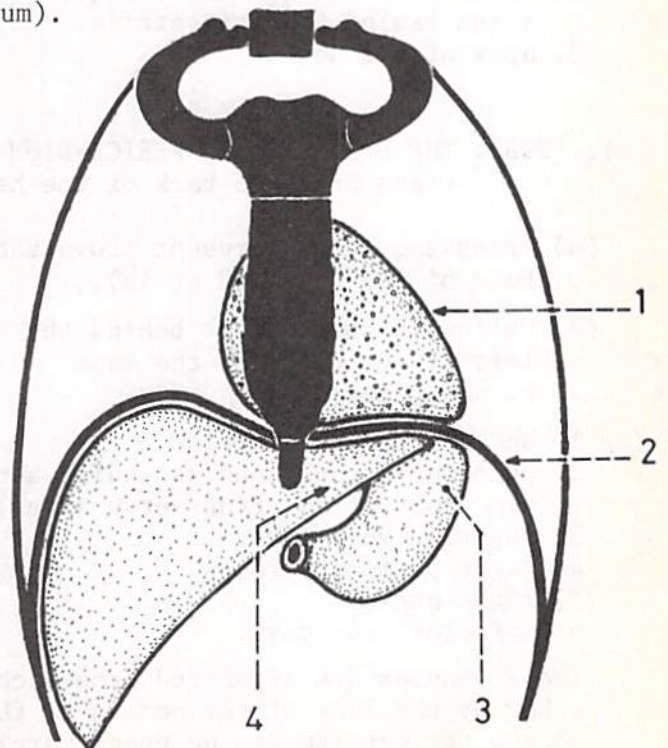
These are : lung and pleura, phrenic nerve and pericardiophrenic vessels.

1. oesophagus (behind the pericardium).
2. sternum.
3. thymus gland (in front of the pericardium).
4. pericardium.
5. phrenic nerve and pericardiophrenic artery (on the side of the pericardium).
6. left lung.
7. descending aorta (behind the pericardium).

Fig.(290): STRUCTURES BELOW THE PERICARDIUM

These are the diaphragm, liver and fundus of the stomach.

1. pericardium.
2. diaphragm (separates the pericardium from the liver and the stomach).
3. fundus of the stomach.
4. left lobe of the liver.



SINUSES OF THE PERICARDIUM

Fig.(291): TRANSVERSE SINUS OF PERICARDIUM

It is a transverse passage inside the pericardial cavity, just behind the ascending aorta and pulmonary trunk. It lies above the base of the heart represented by the 2 atria.

1. superior vena cava.
2. right pulmonary artery (above the transverse sinus).
3. arrow passing through the sinus.
4. ascending aorta.
5. pulmonary trunk.
6. left auricle.

* The arrow (3) enters the sinus in front of the S.V.C. and leaves the sinus in front of the left auricle.

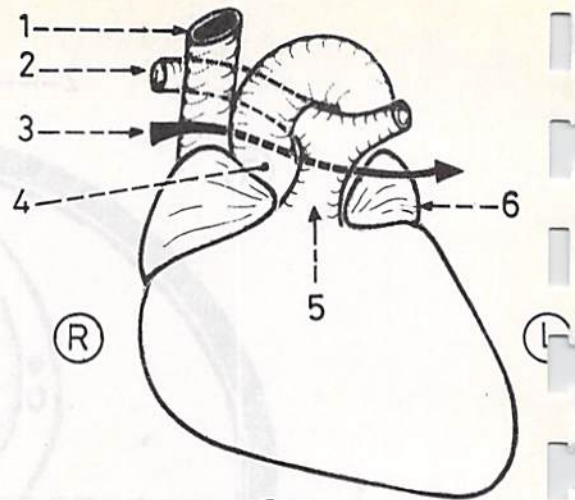


Fig.(292): SITE OF THE OBLIQUE SINUS OF PERICARDIUM

It is a blind pouch placed behind the base of the heart represented by the left atrium.

1. wall of the pericardium (cut to open the pericardial cavity).
2. arrow passing into the oblique sinus behind the left atrium.
3. apex of the heart.

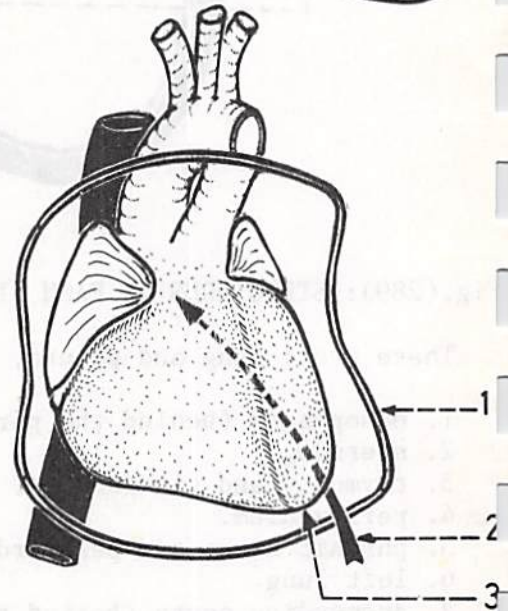


Fig.(293): THE 2 SINUSES OF PERICARDIUM (seen from the back of the heart)

- (a) Transverse sinus present above the base of the heart (2 atria).
- (b) Oblique sinus present behind the left atrium (part of the base of the heart).

1. back of the left atrium.
2. pulmonary trunk and ascending aorta (in front of the transverse sinus).
3. superior vena cava.
4. right pulmonary veins.
5. right atrium.
6. inferior vena cava.

The 2 sinuses are separated from each other by the line of reflection of the serous pericardium at the upper margin of left atrium.

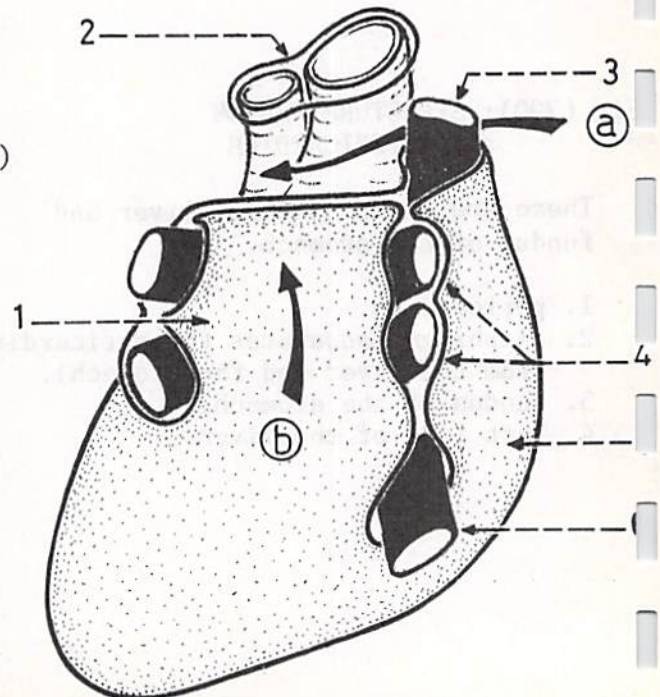


Fig.(294): BOUNDARIES OF THE OBLIQUE SINUS OF PERICARDIUM
(heart is removed)

It is bounded above by reflection of the serous pericardium on the back of the left atrium, on the right side by the 2 venae cavae and the 2 right pulmonary veins, on the left side by the 2 left pulmonary veins, while below the sinus is open where its entrance lies.

(a) Transverse sinus.

(b) Oblique sinus.

1. superior vena cava.
2. right pulmonary veins.
3. inferior vena cava.
4. upper boundary of the oblique sinus (reflection of serous pericardium).
5. left pulmonary veins (left boundary).
6. entrance of oblique sinus (bounded by the left lower pulmonary vein and I.V.C.).

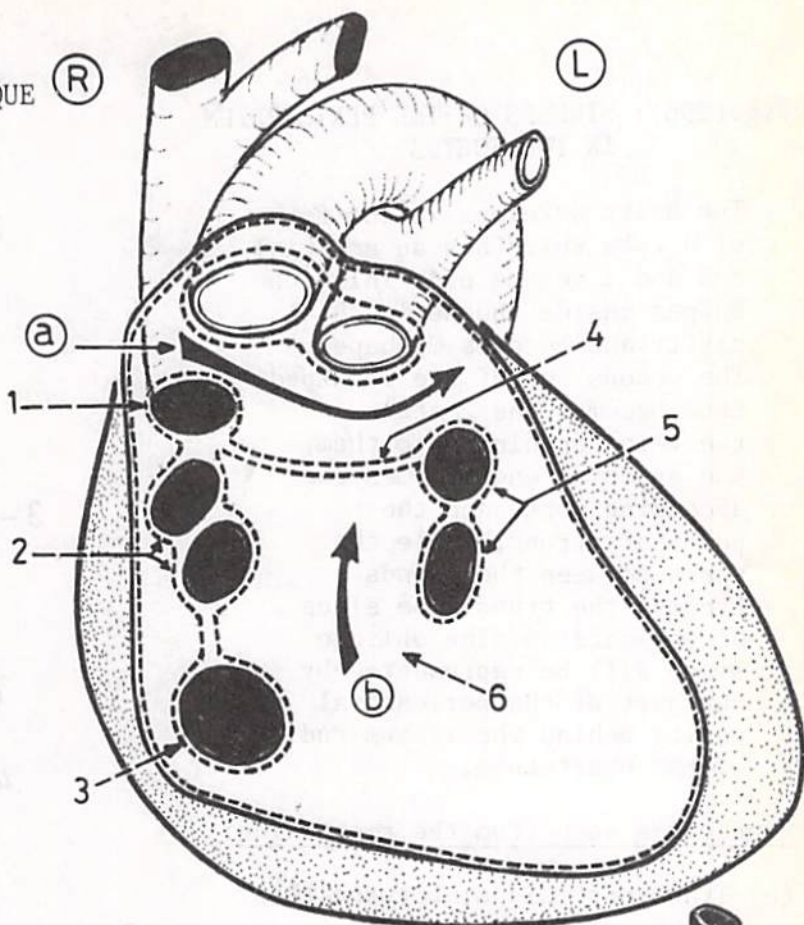
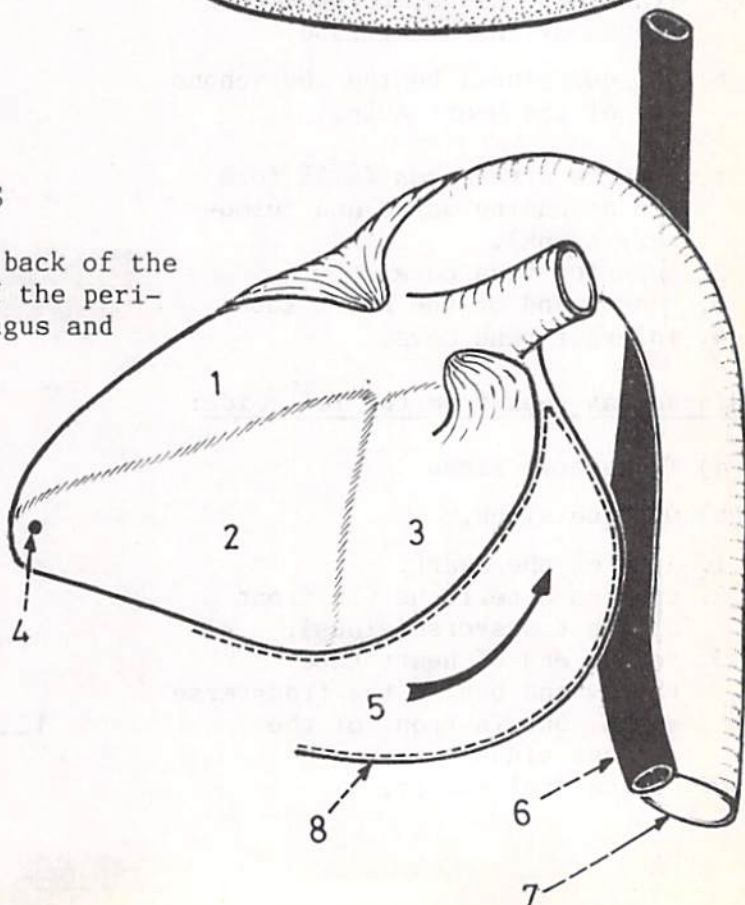


Fig.(295): RELATIONS OF OBLIQUE SINUS

The sinus is related in front to the back of the left atrium, while behind, the wall of the pericardium separates it from the oesophagus and descending aorta.

1. right ventricle.
2. left ventricle.
3. left atrium.
4. apex of the heart.
5. arrow in the oblique sinus (closed from above).
6. oesophagus (behind the sinus).
7. descending aorta (behind the sinus).
8. posterior wall of the sinus (pericardium).



* This is a left side view of the heart and the oblique sinus.

Fig.(296): SINUSES OF THE PERICARDIUM
IN THE FOETUS

The heart develops in the form of a tube which has an arterial end and a venous end. This tube bulges inside the pericardial cavity and becomes U-shaped. The venous end of the U-shaped tube becomes the 2 atria and the veins opening into them, the arterial end becomes the ascending aorta and the pulmonary trunk, while the space between the 2 ends becomes the transverse sinus of pericardium. The oblique sinus will be represented by the part of the pericardial cavity behind the venous end of the heart tube.

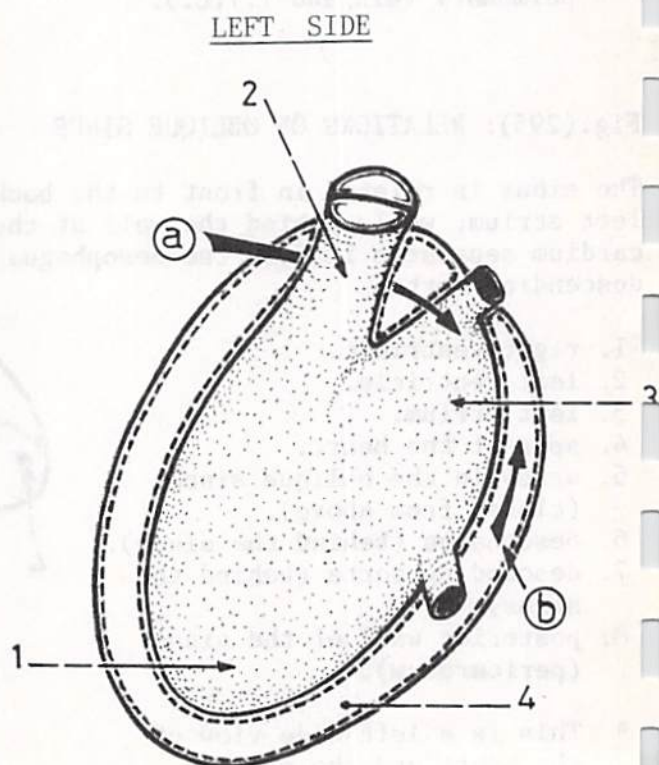
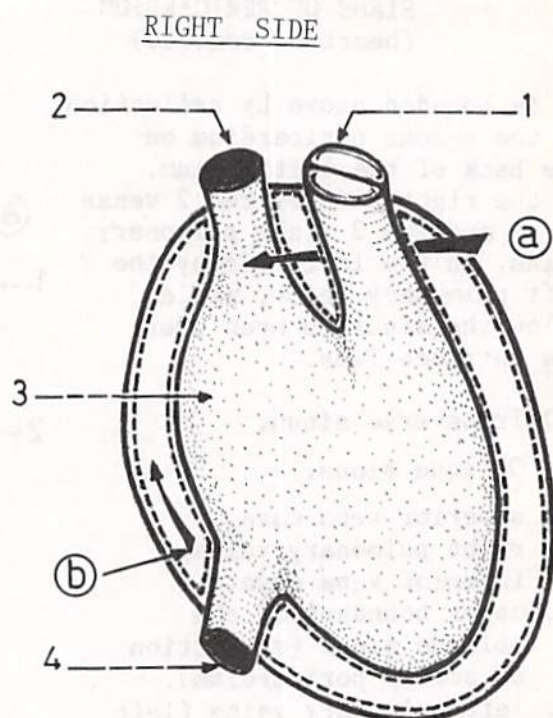
Sinuses as seen from the right side:

- (a) Transverse sinus: between the 2 ends of the heart tube.
- (b) Oblique sinus: behind the venous end of the heart tube.

1. truncus arteriosus (will form the ascending aorta and pulmonary trunk).
2. superior vena cava.
3. venous end of the heart tube.
4. inferior vena cava.

Sinuses as seen from the left side:

- (a) Transverse sinus.
 - (b) Oblique sinus.
1. apex of the heart.
 2. truncus arteriosus (in front of the transverse sinus).
 3. venous end of heart tube (below and behind the transverse sinus, but in front of the oblique sinus).
 4. pericardial cavity.



HEART

EXTERNAL FEATURES OF THE HEART

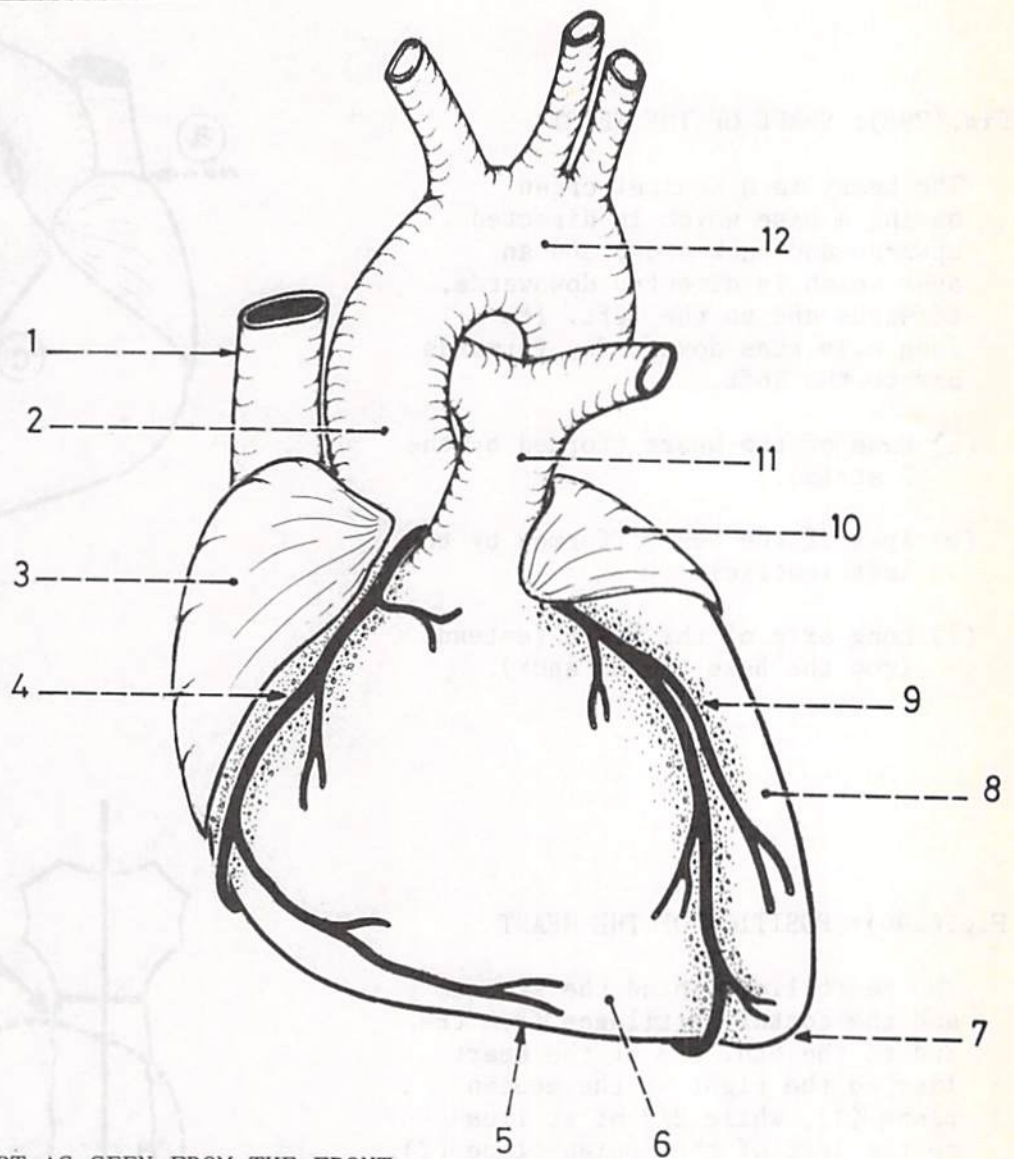


Fig.(297): THE HEART AS SEEN FROM THE FRONT

1. superior vena cava.
2. ascending aorta.
3. right auricle.
4. atrioventricular groove containing the right coronary artery.
5. lower border of the heart.
6. right ventricle.
7. apex of the heart.
8. left ventricle.
9. anterior interventricular groove containing the anterior interventricular artery (from the left coronary).
10. left auricle.
11. pulmonary trunk.
12. arch of the aorta.

Fig.(298): SHAPE OF THE HEART

The heart is a conical organ having a base which is directed upwards and backwards, and an apex which is directed downwards, forwards and to the left. Its long axis runs downwards, forwards and to the left.

- (a) Base of the heart (formed by the 2 atria).
- (b) Apex of the heart (formed by the left ventricle).
- (c) Long axis of the heart (extends from the base to the apex).

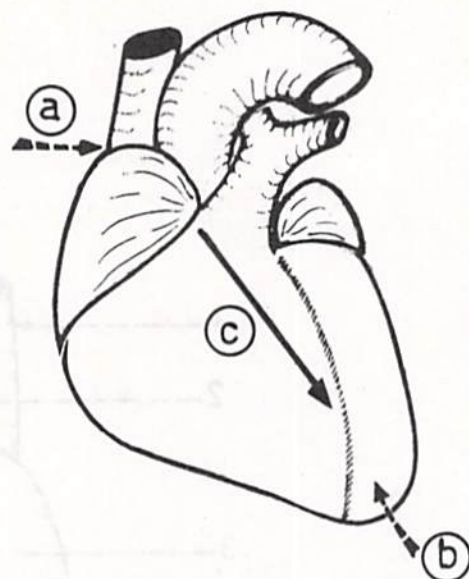


Fig.(299): POSITION OF THE HEART

The heart lies behind the sternum and the costal cartilages from the 2nd to the 6th. 1/3 of the heart lies to the right of the median plane (1), while 2/3 of it lies to the left of the median plane (2).

- (a) Base of the heart.
- (b) Apex of the heart.
- (c) Median plane.

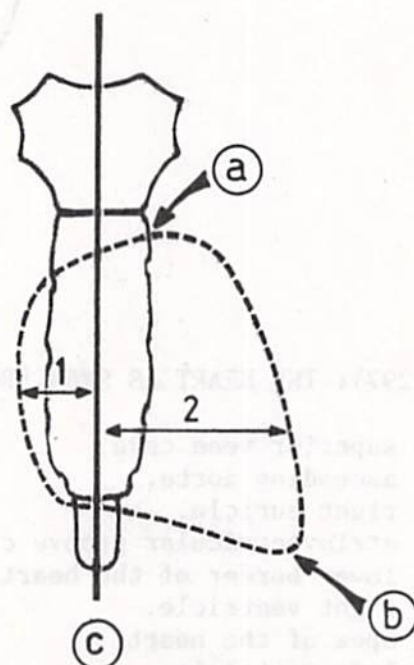


Fig.(300): ATRIOVENTRICULAR (CORONARY) SULCUS

The atrioventricular (A-V) sulcus encircles the heart transversely between the atrial part (base) and the ventricular part. This sulcus is incomplete anteriorly where it is interrupted by the roots of the pulmonary trunk and ascending aorta.

1. anterior part of the A-V sulcus (stops at the roots of the pulmonary trunk and ascending aorta).
2. auricle of the right atrium.
3. auricle of the left atrium.
4. posterior part of the A-V sulcus.
5. ventricular part of the heart (below the sulcus).

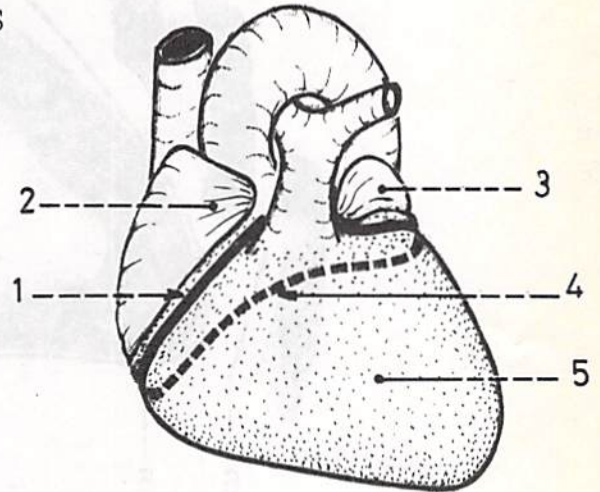
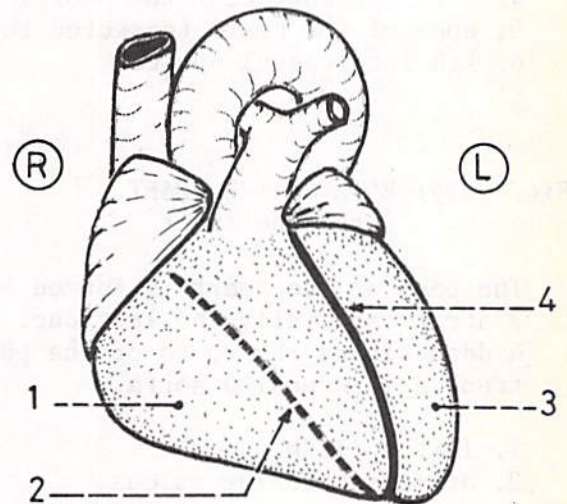


Fig.(301): INTERVENTRICULAR GROOVES

The right and left ventricles are separated from each other on the anterior surface of the heart by the anterior interventricular groove, and on the inferior surface by the inferior interventricular groove. These 2 grooves run in the long axis of the heart and are continuous together a little distance to the right of the apex of the heart.

1. right ventricle.
2. inferior interventricular groove (on the inferior surface).
3. left ventricle.
4. anterior interventricular groove (on the anterior surface).



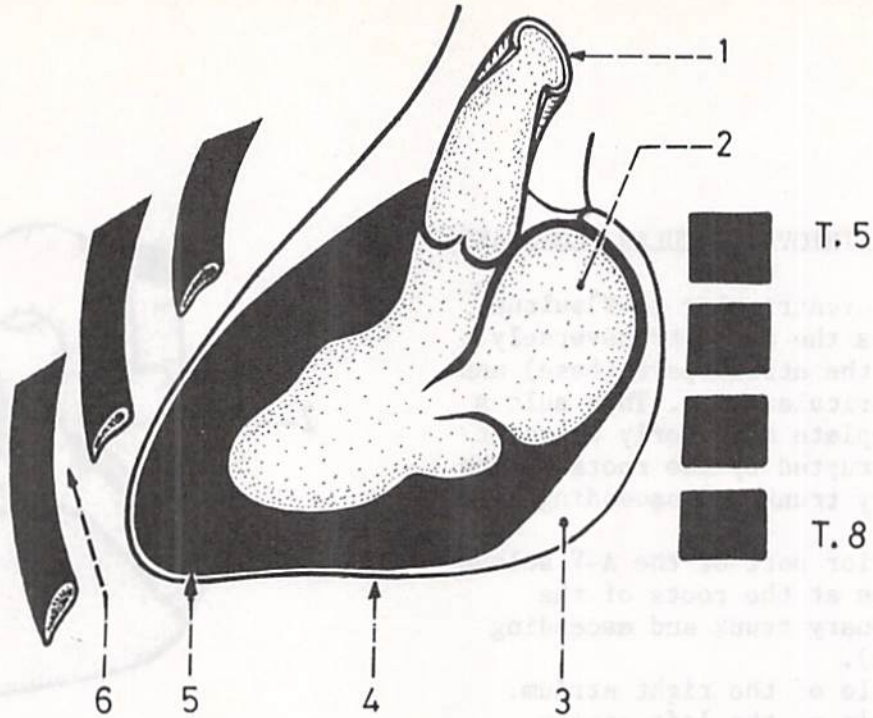


Fig.(302): POSITION OF THE BASE AND APEX OF THE HEART

The base of the heart is directed backwards where it rests on the thoracic vertebrae from 5 to 8. The apex of the heart is directed downwards and forwards towards the chest wall where it lies opposite the 5th intercostal space, 9 cm from the midline.

- 1. ascending aorta.
- 2. left atrium (forms most of the base of the heart).
- 3. oblique sinus of pericardium (behind the left atrium).
- 4. inferior surface of the heart.
- 5. apex of the heart (directed towards the chest wall).
- 6. 5th intercostal space.

Fig.(303): BASE OF THE HEART
(from the front)

The base of the heart is formed by the 2 atria especially the left one. It is hidden behind the roots of the pulmonary trunk and ascending aorta.

- 1. left auricle.
- 2. atrioventricular sulcus.
- 3. ventricular part of the heart.
- 4. root of pulmonary trunk.

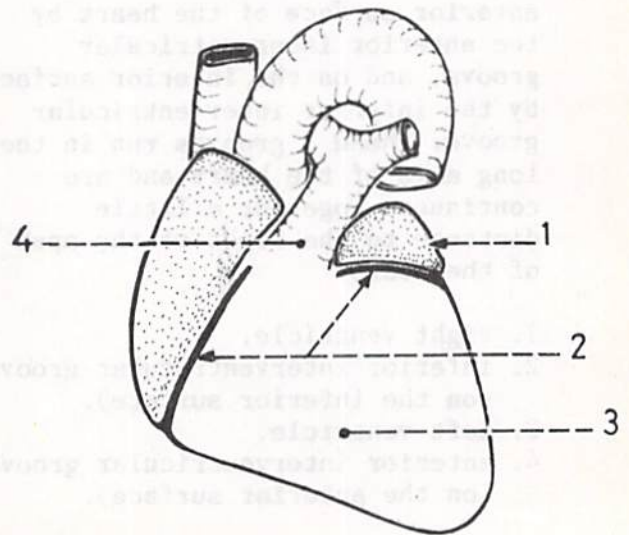


Fig.(304): POSTERIOR RELATIONS OF THE
BASE OF THE HEART

These are the oesophagus, descending aorta and the right pulmonary veins.

1. right atrium.
2. right pulmonary veins passing behind the right atrium to open into the back of the left atrium (represented by arrows).
3. oesophagus.
4. descending aorta.
5. left atrium (forms most of the base).
6. root of pulmonary trunk (cut).

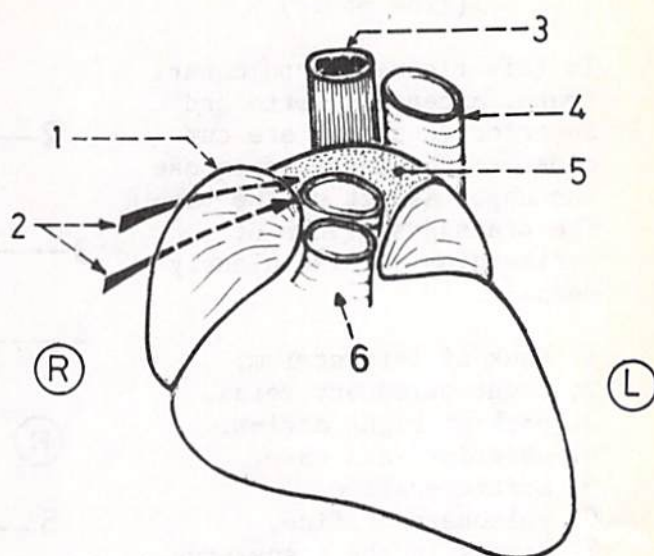
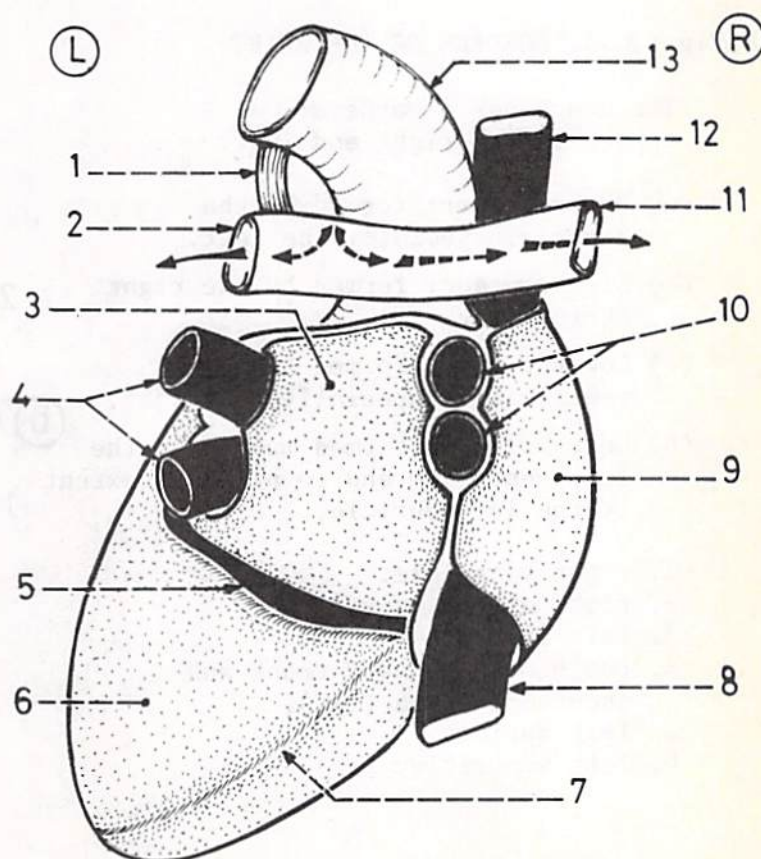


Fig. (305): BASE OF THE HEART
(from the back)

The base of the heart and its boundaries are better seen from the back. In this view, the 4 pulmonary veins are seen entering the back of the left atrium, 2 on each side.

1. ligamentum arteriosum (between the arch of the aorta and left pulmonary artery).
2. left pulmonary artery.
3. back of the left atrium.
4. left 2 pulmonary veins.
5. posterior part of the atrio-ventricular sulcus (lower boundary of the base).
6. back of left ventricle.
7. inferior interventricular groove.
8. inferior vena cava (entering the back of the right atrium).
9. back of right atrium.
10. right 2 pulmonary veins.
11. right pulmonary artery (passing horizontally above the base of the heart).
12. superior vena cava (entering the back of the right atrium).
13. arch of the aorta.



* Note that a small part of the base of the heart is formed by the right atrium as compared with the left atrium.

Fig.(306): BASE OF THE HEART
(from above)

In this figure the pulmonary trunk, ascending aorta and superior vena cava are cut close to the heart to expose the upper aspect of the base. The transverse sinus of pericardium is also clearly seen.

1. back of left atrium.
2. right pulmonary veins.
3. back of right atrium.
4. superior vena cava.
5. aortic orifice.
6. pulmonary orifice.
7. arrows in the transverse sinus of pericardium.
8. left pulmonary veins.

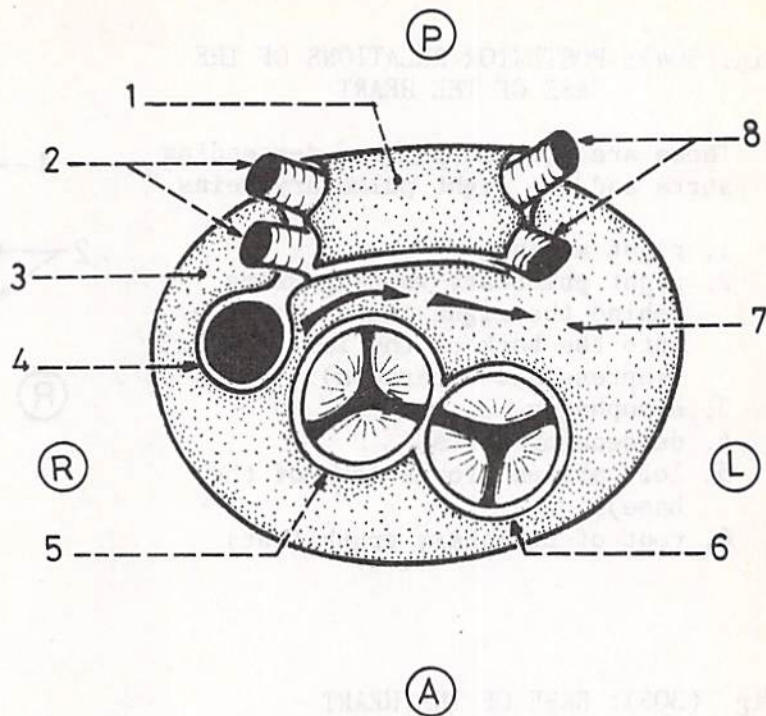


Fig.(307): BORDERS OF THE HEART

The heart has 4 borders:
upper, lower, right and left.

- (a) Upper border: formed by the 2 atria, especially the left.
- (b) Right border: formed by the right atrium only.
- (c) Lower border: formed by the 2 ventricles, especially the right.
- (d) Left border: formed mainly by the left ventricle and to a lesser extent by the left auricle.

1. right ventricle.
2. right atrium.
3. left atrium.
4. roots of pulmonary trunk and ascending aorta (cut).
5. left auricle.
6. left ventricle.

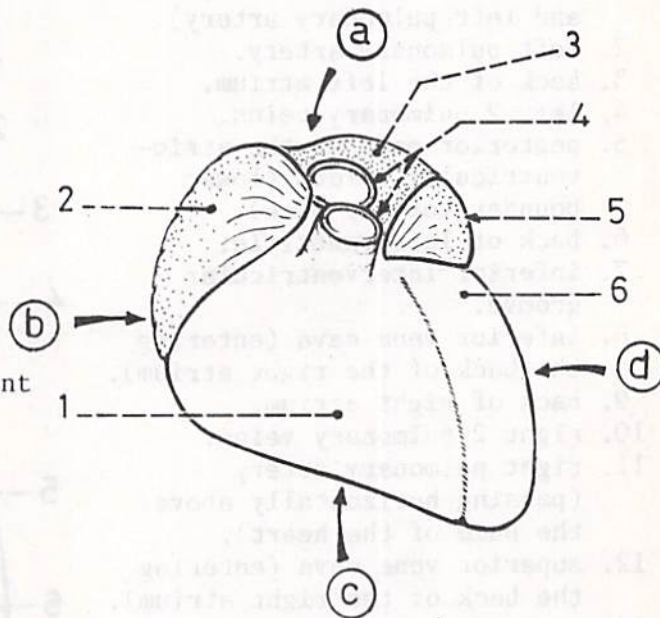


Fig.(308): STERNOCOSTAL SURFACE OF THE HEART

It consists of an atrial part (formed by right atrium and left auricle), ventricular part (formed by the 2 ventricles, especially the right) and the roots of pulmonary trunk and ascending aorta.

1. root of pulmonary trunk.
2. right atrium and its auricle.
3. right ventricle.
4. left ventricle.
5. anterior interventricular groove.
6. auricle of left atrium.

* This surface faces the sternum and costal cartilages, and is identified by the pulmonary trunk and ascending aorta.

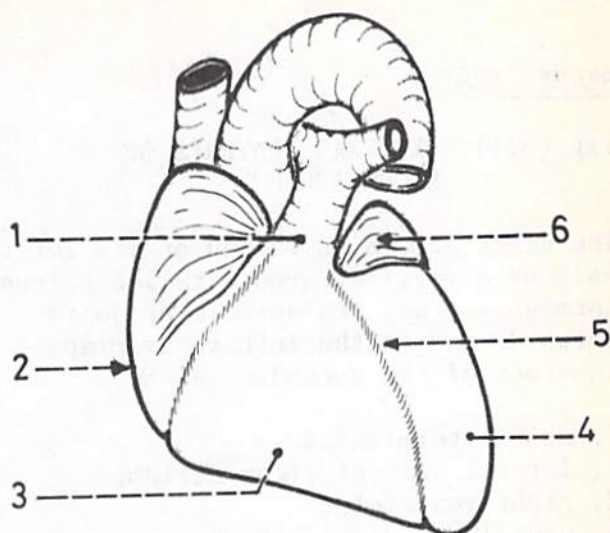


Fig.(309): RIGHT AND LEFT SURFACES OF THE HEART

The right surface is formed only by the right atrium, while the left surface is formed mainly by the left ventricle and to a lesser extent by the left auricle.

1. superior vena cava.
2. right atrium.
3. left ventricle.
4. left auricle.

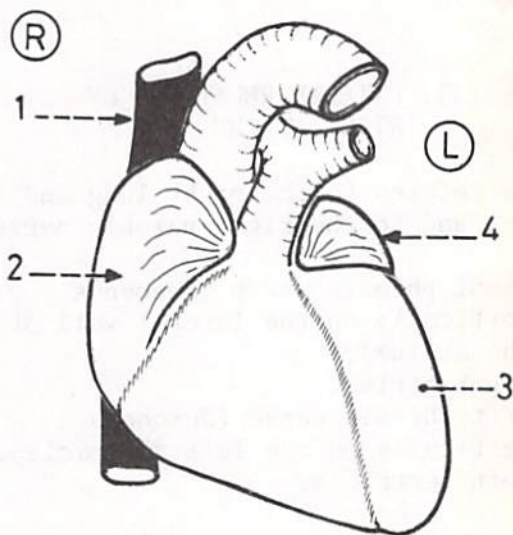
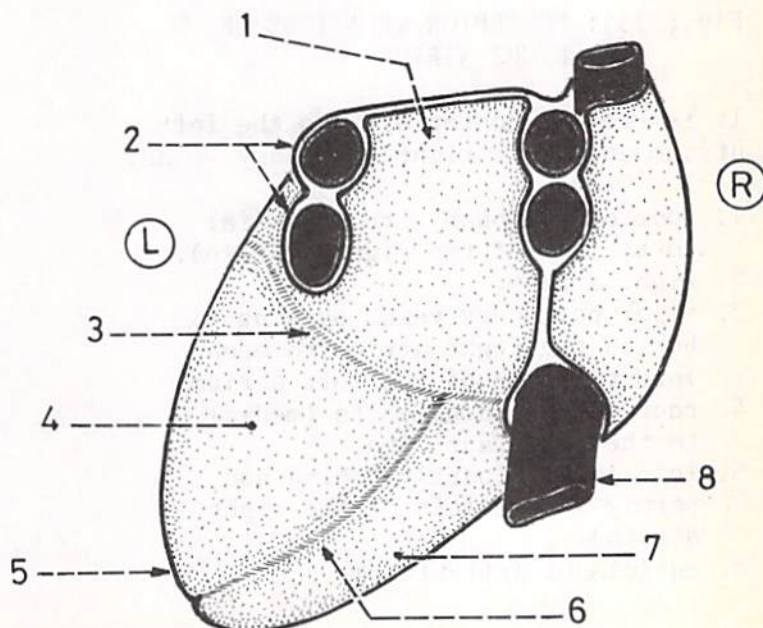


Fig.(310): DIAPHRAGMATIC (INFERIOR) SURFACE OF THE HEART

It is directed downwards towards the diaphragm, and is formed by the 2 ventricles, especially the left.

1. left atrium.
2. left pulmonary veins.
3. atrioventricular sulcus.
4. left ventricle.
5. apex of the heart.
6. inferior interventricular groove.
7. right ventricle.
8. inferior vena cava.



* The diaphragmatic surface is limited above by the A-V sulcus which separates it from the base of the heart.

RIGHT ATRIUM

Fig.(311): EXTERNAL FEATURES OF
RIGHT ATRIUM

The right atrium is marked on its lateral wall by a vertical groove called sulcus terminalis, and its auricle projects forwards and to the left to overlap the root of the ascending aorta.

1. sulcus terminalis.
2. lateral wall of right atrium.
3. right ventricle.
4. auricle of right atrium.

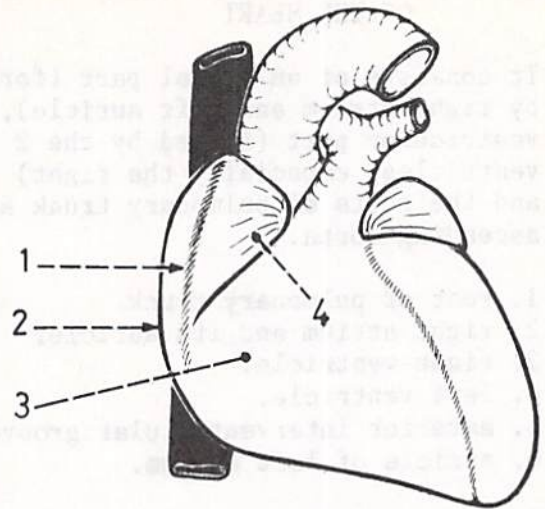


Fig.(312): LATERAL RELATIONS OF
RIGHT ATRIUM

It is related to the right lung and pleura and to the right phrenic nerve.

1. right phrenic nerve (descends vertically on the lateral wall of the atrium).
2. right atrium.
3. left phrenic nerve (descends vertically on the left ventricle).
4. left ventricle.

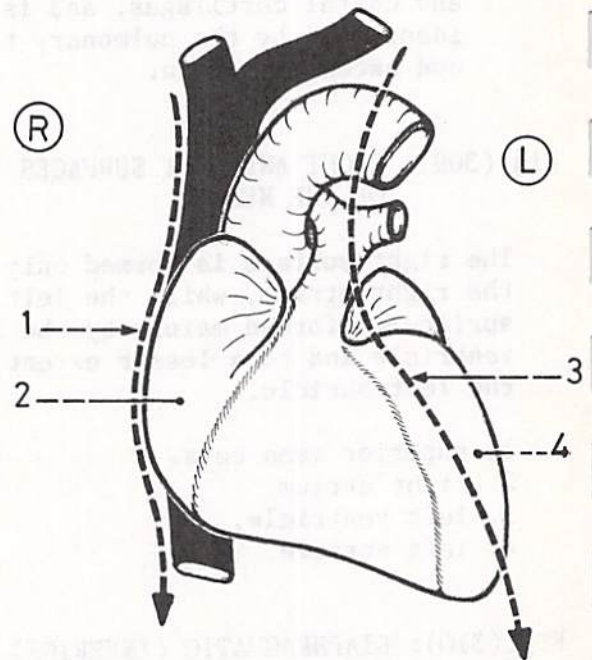


Fig.(313): POSTERIOR RELATIONS OF
RIGHT ATRIUM

It is related posteriorly to the left atrium and the 2 right pulmonary veins.

1. root of pulmonary trunk (medial to the tip of the right auricle).
2. right atrium.
3. right pulmonary veins passing behind the right atrium to open into the back of the left atrium.
4. root of ascending aorta (medial to the right auricle).
5. left atrium (partly behind and partly to the left of the right atrium).
6. auricle of left atrium.

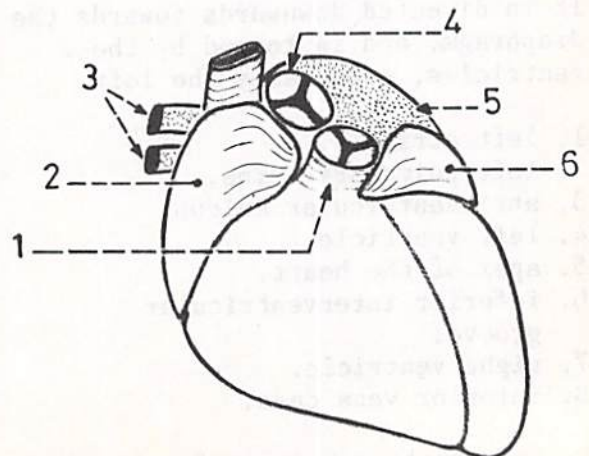


Fig.(314): RELATION OF THE RIGHT ATRIUM
TO THE RIGHT VENTRICLE

The right atrium lies behind the right ventricle and opens into it by the right atrioventricular orifice.

1. pulmonary trunk.
2. ascending aorta.
3. superior vena cava.
4. right atrium.
5. sulcus terminalis.
6. right auricle.
7. inferior vena cava.
8. tricuspid valve (guards the right atrioventricular orifice).
9. cavity of right ventricle (open).

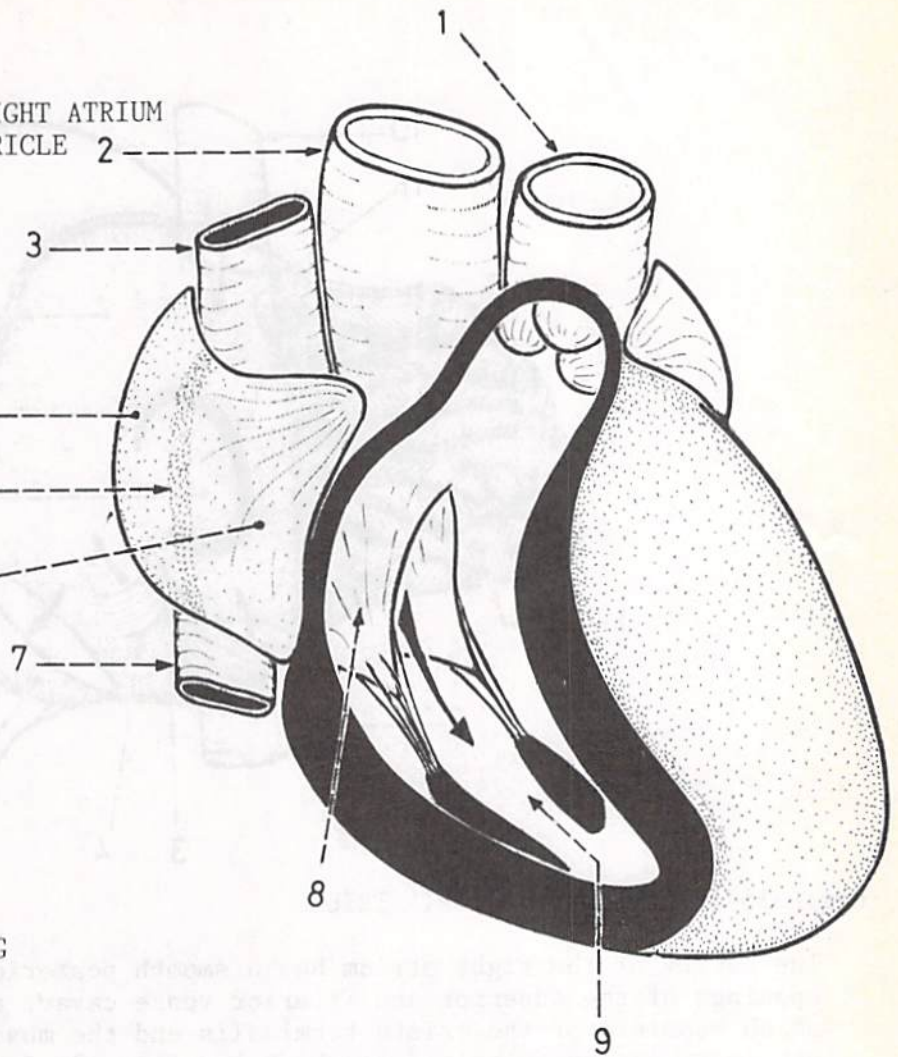
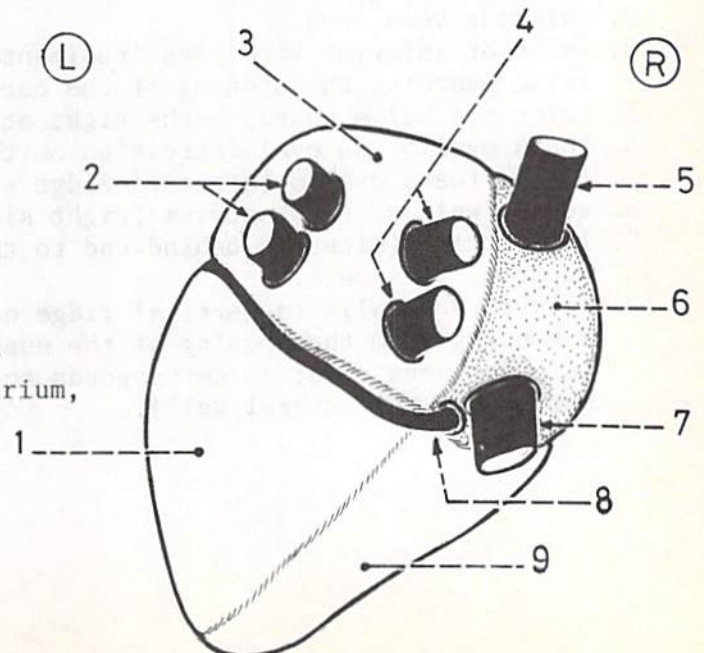


Fig.(315): MAIN VEINS OPENING
INTO RIGHT ATRIUM

These are the superior vena cava, inferior vena cava and coronary sinus.

1. back of left ventricle.
2. left pulmonary veins.
3. back of left atrium.
4. right pulmonary veins.
5. superior vena cava (opens in the upper and posterior part of right atrium).
6. back of right atrium.
7. inferior vena cava (opens in the lower and posterior part of right atrium).
8. coronary sinus (opens in the lower and posterior part of the right atrium, just to the left of the inferior vena cava).
9. back of right ventricle.



* In this figure, the heart is seen from the back.

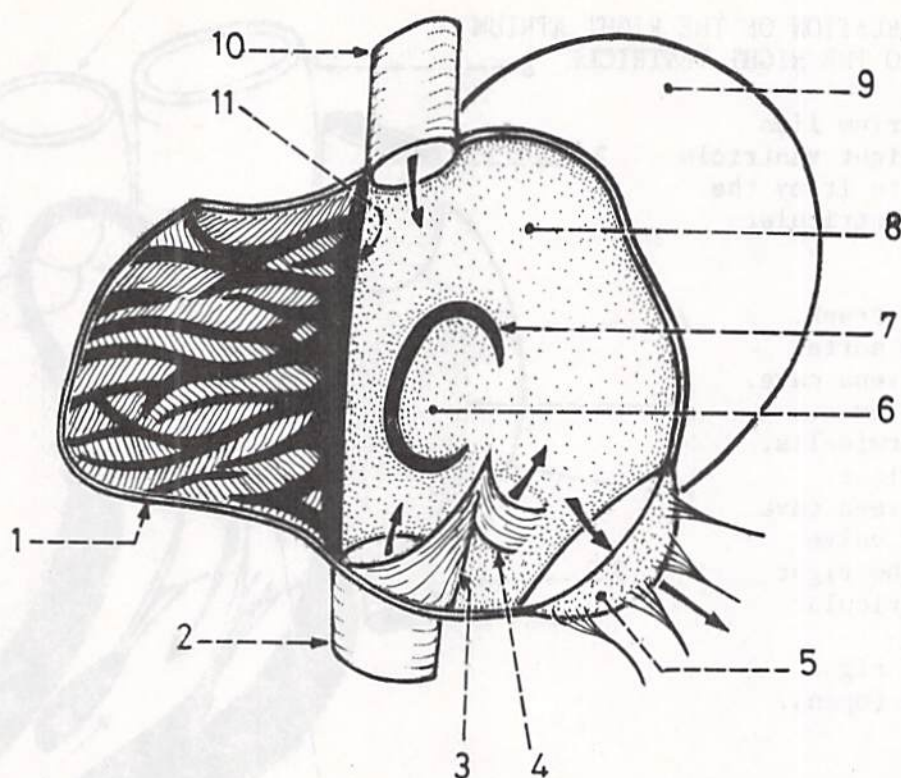


Fig.(316): INTERIOR OF RIGHT ATRIUM

The cavity of the right atrium has a smooth posterior part which receives the openings of the superior and inferior venae cavae, and a rough anterior part which consists of the crista terminalis and the musculi pectinati. The musculi pectinati are muscular ridges which run forwards from the crista terminalis into the auricle of the right atrium.

1. auricle of right atrium showing the musculi pectinati.
2. inferior vena cava.
3. valve of inferior vena cava (rudimentary semilunar valve).
4. valve guarding the opening of the coronary sinus.
5. tricuspid valve guarding the right atrioventricular orifice.
6. fossa ovalis (an oval depression on the lower part of the septal wall).
7. limbus fossa ovalis (a curved ridge around the fossa ovalis; limbus = ridge).
8. septal wall of right atrium (right side of interatrial septum).
9. left atrium (situated behind and to the left of the interatrial septum).
10. superior vena cava.
11. crista terminalis (a vertical ridge on the lateral wall of the atrium extending from the opening of the superior vena cava to that of the inferior vena cava; it corresponds to the sulcus terminalis on the external surface of the lateral wall).

RIGHT VENTRICLE

Fig.(317): EXTERNAL FEATURES OF RIGHT VENTRICLE

The right ventricle forms the central part of the sternocostal surface between the right atrium and left ventricle. It also forms the right 1/3 of the inferior surface and the right 2/3 of the lower border of the heart. Its upper part leads to the pulmonary trunk and is called the infundibulum (conus arteriosus).

1. right atrium.
2. right ventricle.
3. lower border of the heart.
4. left ventricle.
5. anterior interventricular groove.
6. arrow in the infundibulum.

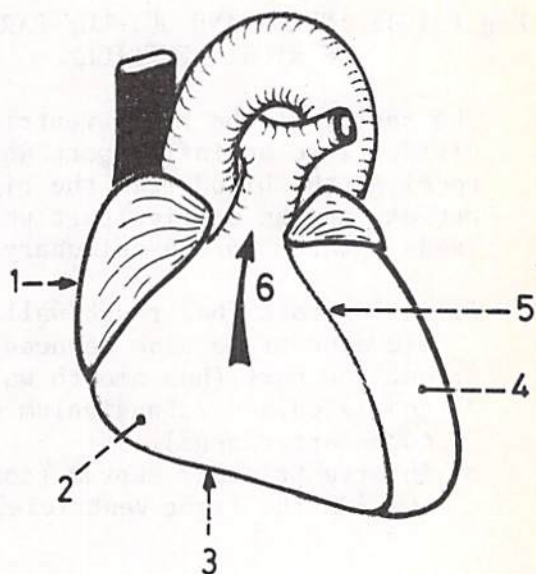


Fig.(318): ANTERIOR RELATIONS OF THE RIGHT VENTRICLE

The anterior surface of the right ventricle comes in direct contact with the lower part of the sternum. A little to the left of the margin of the sternum, the ventricle is covered by pleura and lung.

1. right ventricle.
2. bare area of pericardium not covered by either pleura or lung.
3. anterior border of left pleura.
4. cardiac notch of left lung.
5. bare area of pericardium covered only by pleura but not by lung.

* Note that only a small part of the left lung covers the anterior surface of the right ventricle.

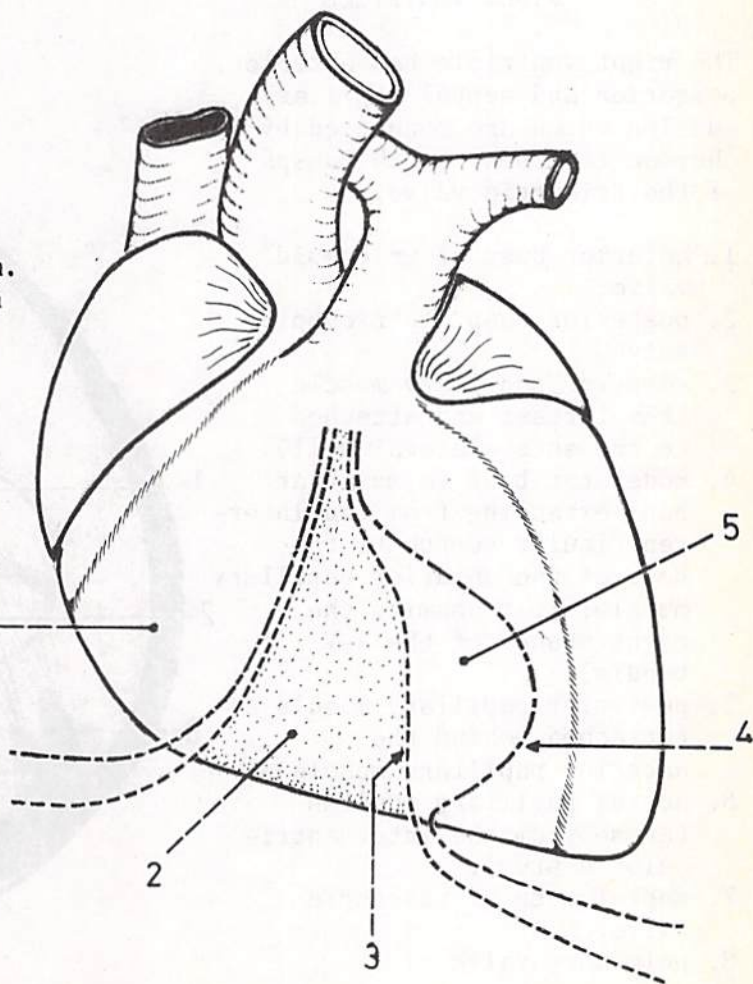


Fig.(319): INFLOW AND OUTFLOW PARTS OF RIGHT VENTRICLE

The cavity of the right ventricle is divided into an inflow part which receives the blood from the right atrium, and an outflow part which leads upwards to the pulmonary orifice.

1. inflow part (has rough walls with elevated trabeculae carneae).
2. outflow part (has smooth walls and is called infundibulum or conus arteriosus).
3. interventricular septum (convex towards the right ventricle).

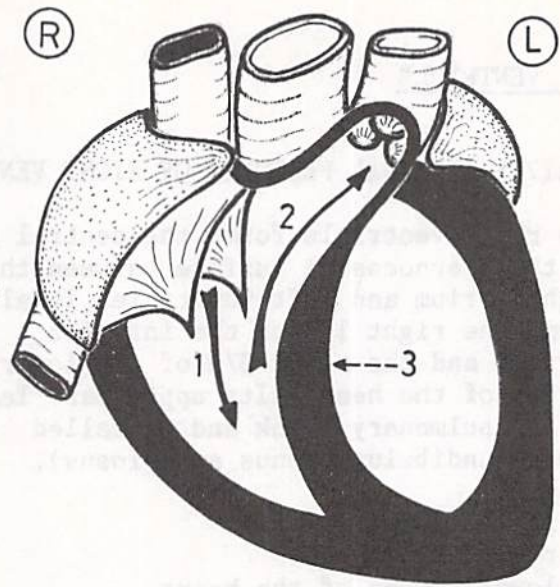


Fig.(320): PAPILLARY MUSCLES OF RIGHT VENTRICLE

The right ventricle has anterior, posterior and septal papillary muscles which are connected by chordae tendineae to the cusps of the tricuspid valve.

1. anterior cusp of tricuspid valve.
2. posterior cusp of tricuspid valve.
3. anterior papillary muscle (the largest and attached to the anterolateral wall).
4. moderator band (a muscular band extending from the interventricular septum to the base of the anterior papillary muscle; it transmits the right branch of the A-V bundle).
5. posterior papillary muscle (attached behind the anterior papillary muscle).
6. septal papillary muscles (arise from the interventricular septum).
7. septal cusp of tricuspid valve.
8. pulmonary valve.

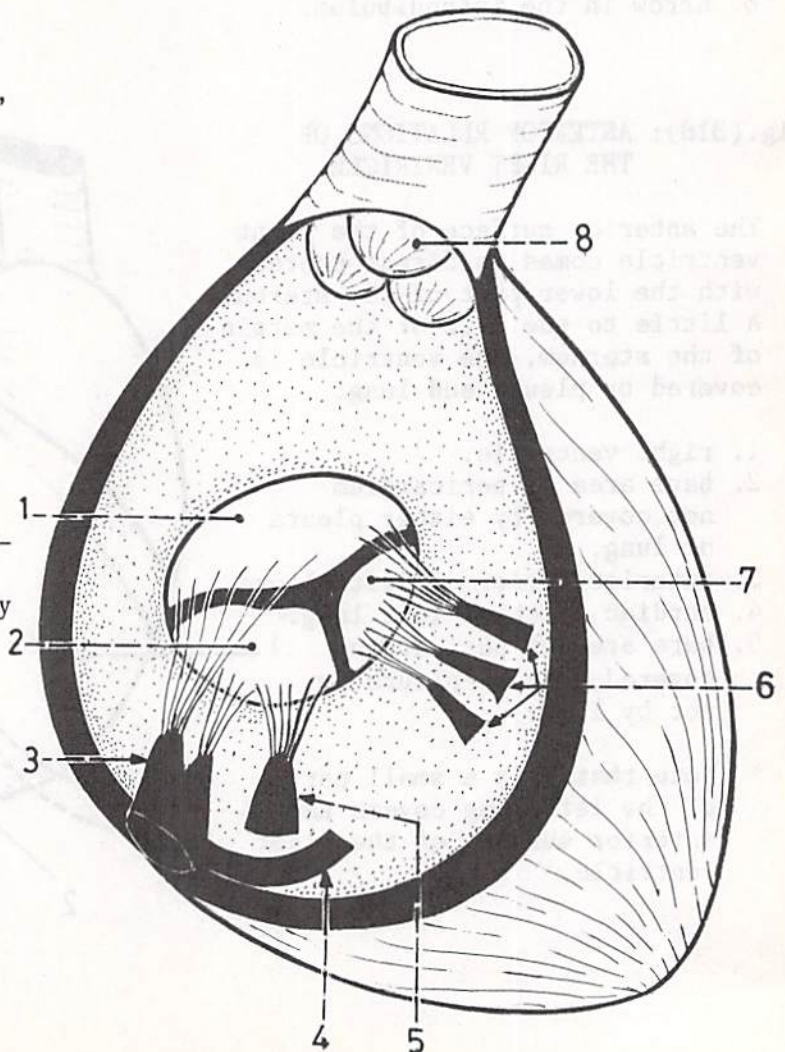


Fig.(321): TRICUSPID VALVE

It guards the right atrioventricular orifice and consists of 3 cusps: anterior cusp corresponding to the anterior papillary muscle, posterior cusp corresponding to the posterior papillary muscle and septal cusp corresponding to the septal papillary muscles.

1. arrow representing the direction of blood from right atrium to right ventricle.
2. ventricular surface of the cusp (rough and gives attachment to the chordae tendineae). This is the anterior cusp.
3. chordae tendineae.
4. anterior papillary muscle.
5. moderator band.
6. posterior papillary muscle.
7. atrial surface of the cusp (smooth). This is the posterior cusp.
8. septal papillary muscles.
9. septal cusp.

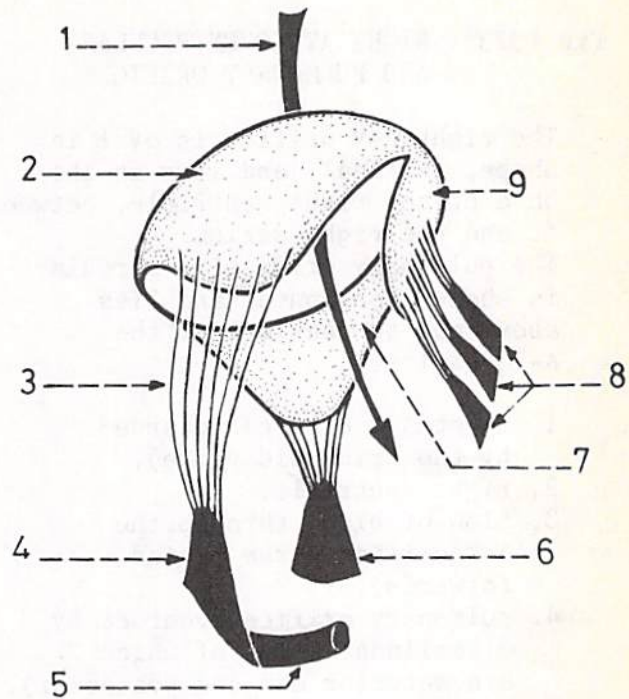


Fig.(322): ATTACHMENT OF THE CHORDAE TENDINEAE TO THE CUSPS OF THE TRICUSPID VALVE

The chordae tendineae arise from the free ends of the papillary muscles and are inserted into the adjacent parts of 2 cusps at their margins and ventricular surfaces.

1. anterior papillary muscle.
2. anterior cusp.
3. arrow passing through the A-V orifice.
4. septal cusp.
5. septal papillary muscle.
6. posterior cusp.
7. posterior papillary muscle.

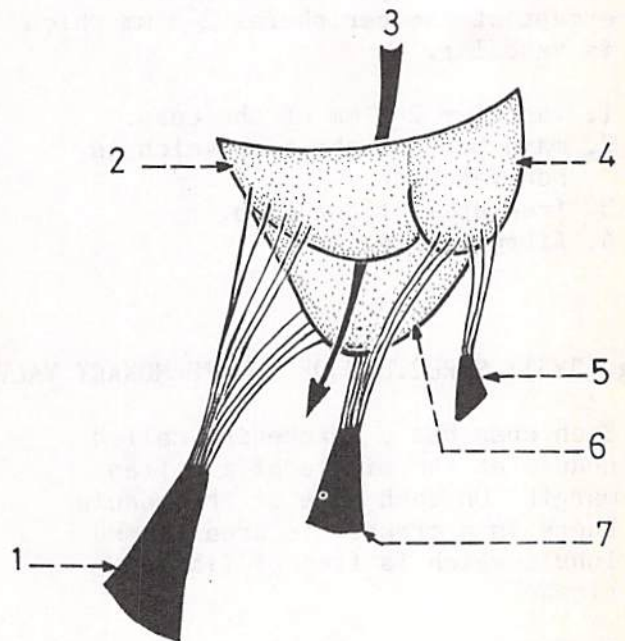


Fig.(323): RIGHT ATRIOVENTRICULAR
AND PULMONARY ORIFICES

The right A-V orifice is oval in shape, vertical and lies at the base of the right ventricle, between it and the right atrium. The pulmonary orifice is circular in shape, horizontal and lies above and to the left of the A-V orifice.

1. right A-V orifice (guarded by the tricuspid valve).
2. right ventricle.
3. flow of blood through the A-V orifice (from behind forwards).
4. pulmonary orifice (guarded by 3 semilunar cusps of which 2 are anterior and one posterior).
5. flow of blood in the infundibulum.

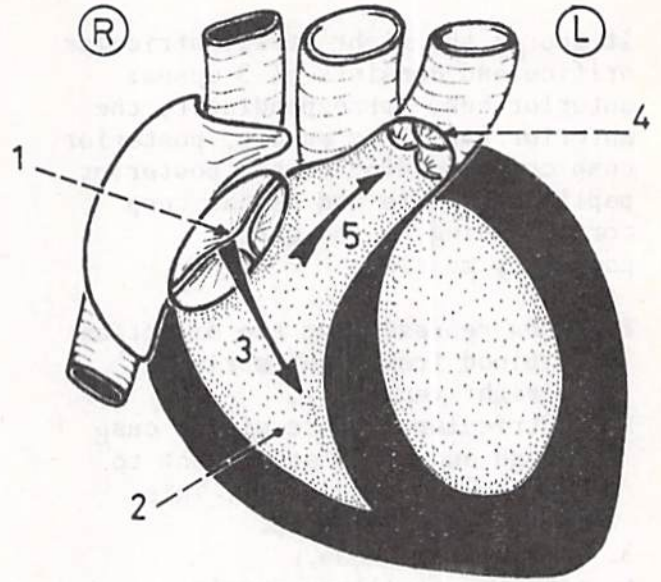


Fig.(324): STRUCTURE OF THE TRICUSPID VALVE

The valve is surrounded by a fibrous ring which gives attachment to the 3 cusps. The cusps are non-vascular except at the peripheral 2-3 mm which is vascular.

1. vascular 2-3 mm of the cusp.
2. main part of the cusp which is non-vascular.
3. free apex of the cusp.
4. fibrous ring.

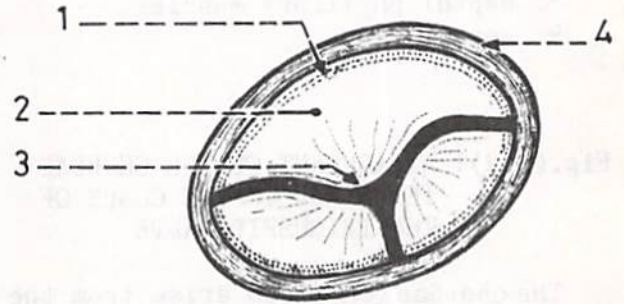
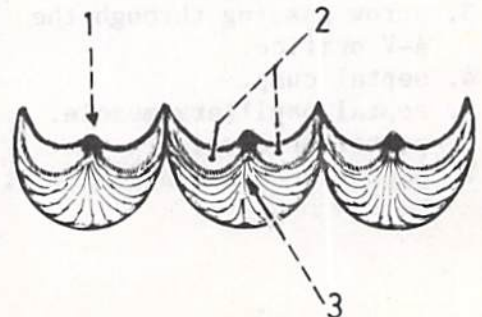


Fig.(325): STRUCTURE OF THE PULMONARY VALVE

Each cusp has a thickening called nodule at the middle of its free margin. On each side of the nodule there is a crescentic area termed lunule which is free of fibrous tissue.

1. nodule at the middle of the free margin.
2. lunules.
3. tendinous fibres radiating from the nodule to the attached margin of the cusp.



LEFT ATRIUM

Fig.(326): POSITION OF LEFT ATRIUM

The left atrium forms the greater part of the base of the heart where it lies behind the right atrium and the roots of the pulmonary trunk and ascending aorta. Its auricle projects forwards on the lateral side of the root of the pulmonary trunk.

1. right atrium (in front and to the right of the left atrium).
2. left atrium (cannot be seen from the front).
3. root of ascending aorta.
4. root of pulmonary trunk.
5. auricle of left atrium (the only part of the left atrium which is seen from the front).

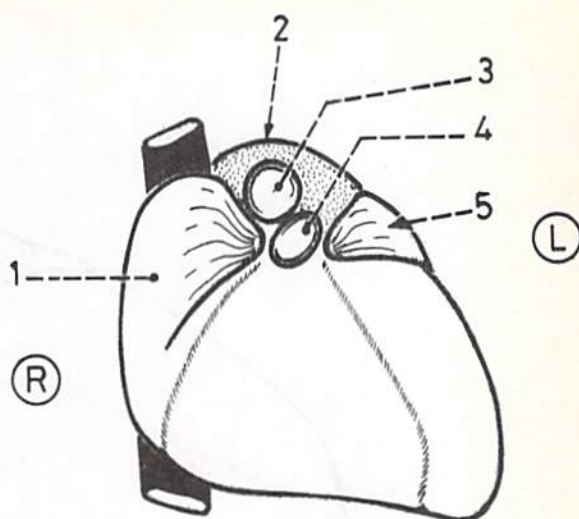
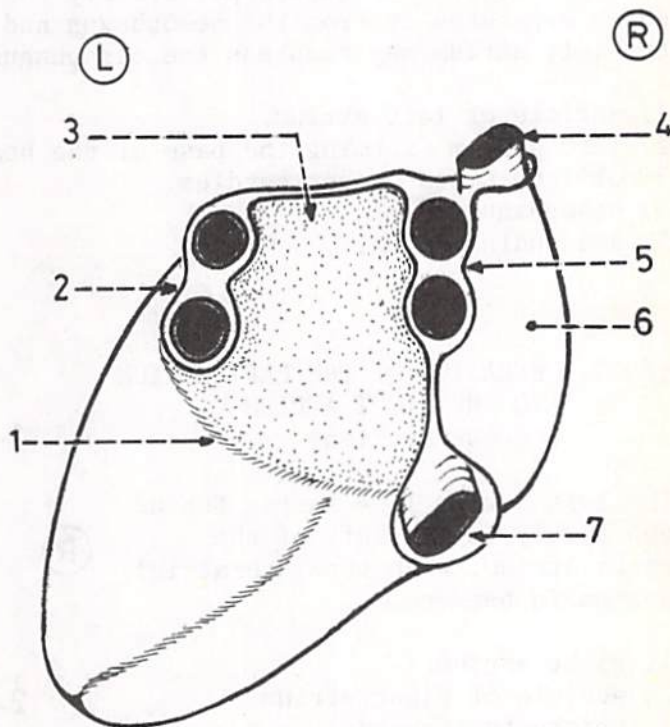


Fig.(327): BACK OF LEFT ATRIUM

The left atrium is well seen on the posterior aspect of the base of the heart where the 4 pulmonary veins enter the atrium, 2 on each side.

1. posterior part of the atrio-ventricular sulcus (lower boundary of left atrium).
2. left pulmonary veins.
3. back of the left atrium (forms the anterior wall of the oblique sinus of pericardium).
4. superior vena cava.
5. right pulmonary veins.
6. right atrium.
7. inferior vena cava.



* The openings of the 4 pulmonary veins form a landmark in identification of the posterior aspect of the heart, while the roots of the pulmonary trunk and ascending aorta form a landmark for the identification of the anterior surface of the heart.

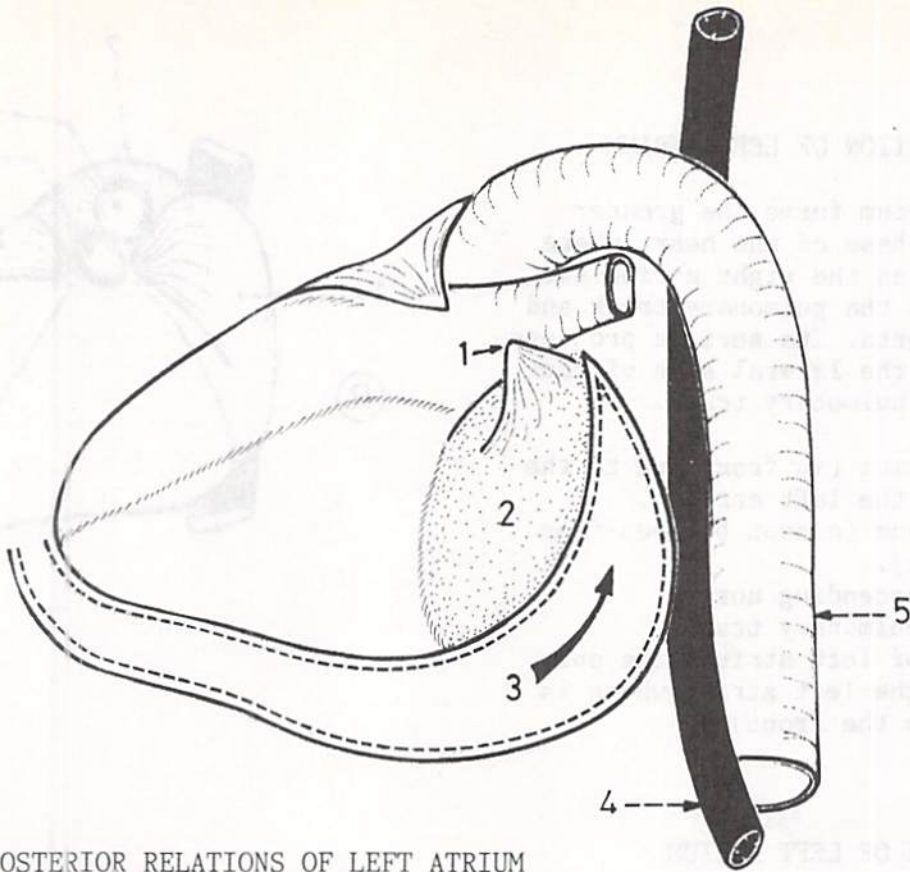


Fig.(328): POSTERIOR RELATIONS OF LEFT ATRIUM

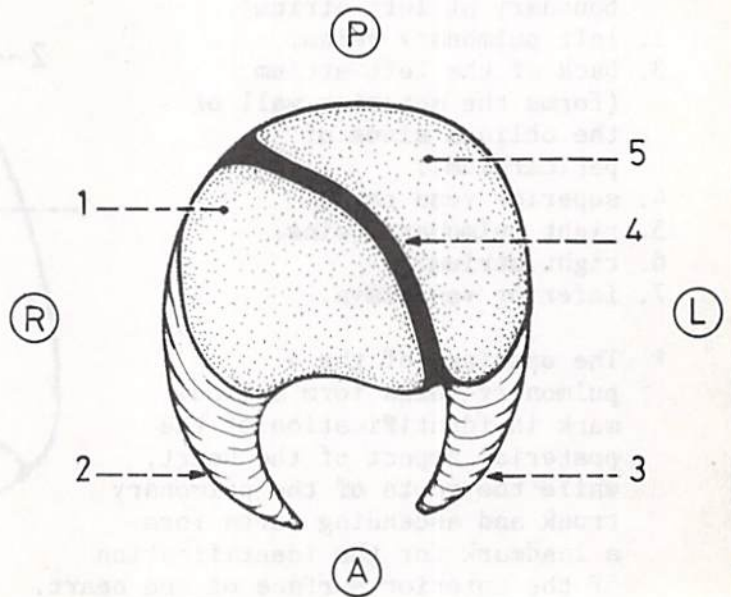
The left atrium is related posteriorly to the oblique sinus of pericardium which separates it from the oesophagus and descending aorta. Enlargement of the left atrium may compress the oesophagus behind.

1. auricle of left atrium.
2. left atrium (forming the base of the heart).
3. oblique sinus of pericardium.
4. oesophagus.
5. descending aorta.

Fig.(329): RELATION OF THE LEFT ATRIUM TO THE RIGHT ATRIUM (cross section)

The left atrium lies partly behind and partly to the left of the right atrium, with the interatrial septum in between.

1. right atrium.
2. auricle of right atrium (projects forwards).
3. auricle of left atrium (projects forwards).
4. interatrial septum (oblique).
5. left atrium.



LEFT VENTRICLE

Fig.(330): LEFT VENTRICLE
(sternocostal surface)

The left ventricle lies to the left of the anterior interventricular groove. It forms the left 1/3 of the sternocostal surface and left 1/3 of the inferior border of the heart. The apex of the heart is formed only by the left ventricle.

1. right atrium.
2. right ventricle.
3. anterior interventricular groove.
4. apex of the heart.
5. left ventricle.
6. left border of the heart.
7. left auricle.

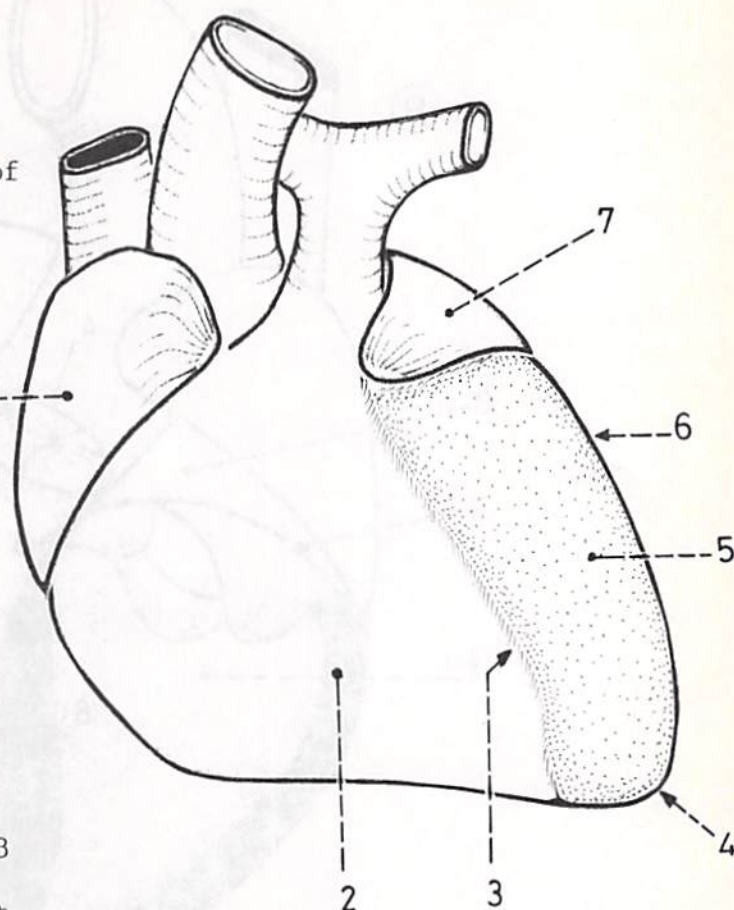
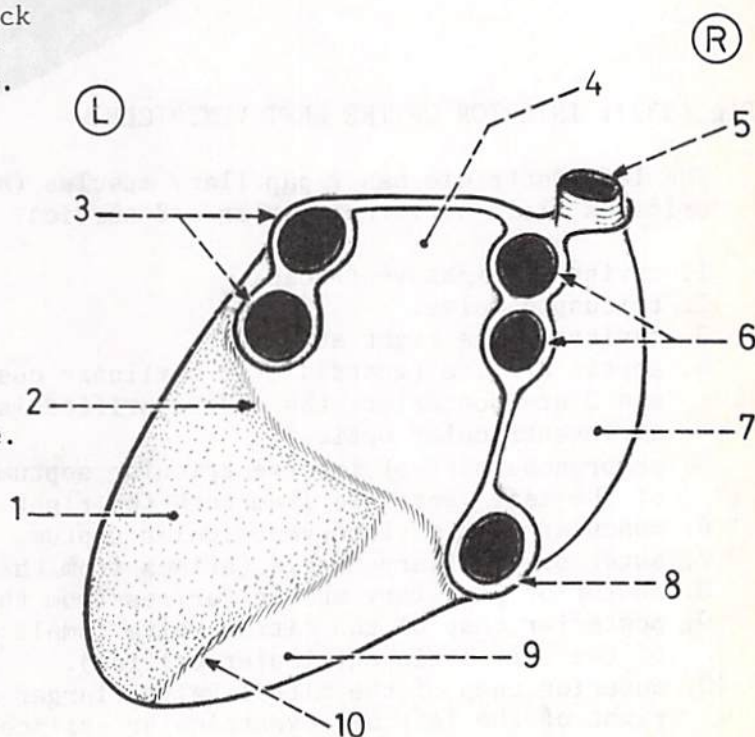


Fig.(331): LEFT VENTRICLE
(diaphragmatic surface)

The left ventricle forms the left 2/3 of the diaphragmatic surface of the heart. It is separated from the right ventricle by the inferior interventricular groove, and from the back of the left atrium by the posterior part of the atrioventricular groove.

1. left ventricle.
2. atrioventricular groove.
3. left pulmonary veins.
4. back of the left atrium.
5. superior vena cava.
6. right pulmonary veins.
7. right atrium.
8. inferior vena cava.
9. right ventricle.
10. inferior interventricular groove.



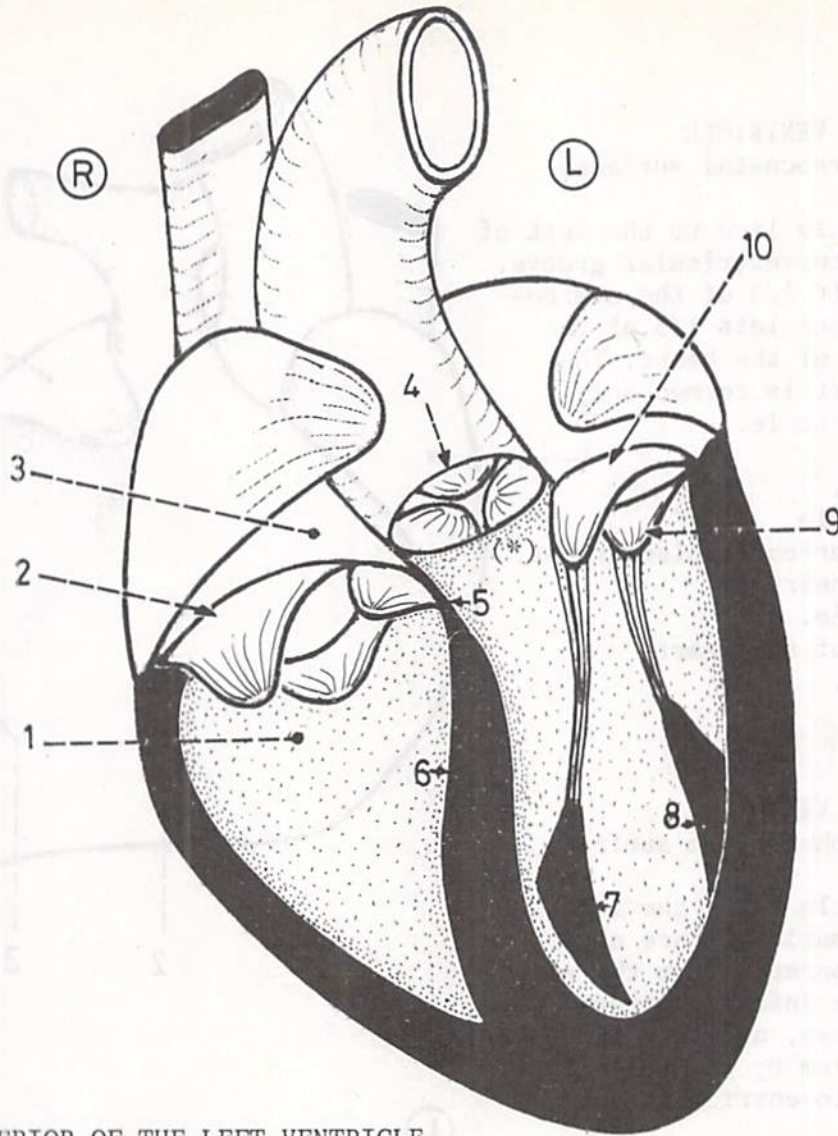


Fig.(332): INTERIOR OF THE LEFT VENTRICLE

The left ventricle has 2 papillary muscles (anterior and posterior), and 2 orifices (left atrioventricular and aortic).

1. cavity of right ventricle.
2. tricuspid valve.
3. cavity of the right atrium.
4. aortic orifice (guarded by 3 semilunar cusps of which one is anterior and 2 are posterior; the aortic orifice is in direct contact with the left atrioventricular orifice).
5. membranous part of interventricular septum (separates the aortic vestibule of the left ventricle from both the right ventricle and right atrium).
6. muscular part of interventricular septum.
7. anterior papillary muscle (arises from the anterior wall of left ventricle).
8. posterior papillary muscle (arises from the posterior wall of left ventricle).
9. posterior cusp of the mitral valve (small and placed behind and to the left of the left atrioventricular orifice).
10. anterior cusp of the mitral valve (larger and placed in front and to the right of the left atrioventricular orifice).

* Note that the upper part of the left ventricle just below the aortic orifice is called aortic vestibule (*).

Fig.(333): MITRAL VALVE

It is the bicuspid valve which guards the left atrioventricular orifice.

1. flow of blood from behind forwards.
2. anterior cusp (placed anteriorly and to the right).
3. chordae tendineae.
4. anterior papillary muscle.
5. posterior papillary muscle.
6. posterior cusp (behind and to the left).

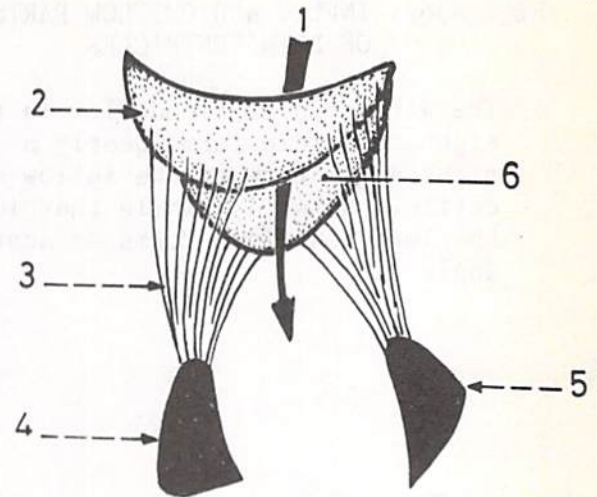


Fig.(334): INFLOW AND OUTFLOW PARTS OF THE LEFT VENTRICLE

The inflow part extends from the left A-V orifice to the apex of the heart, while the outflow part extends from the apex of the heart to the aortic orifice.

1. aortic orifice.
2. anterior cusp of mitral valve (intervenes between the left A-V orifice and aortic orifice).
3. left atrium.
4. left ventricle.
5. direction of blood in the inflow part (from behind forwards).
6. direction of blood in the outflow part (from below upwards).

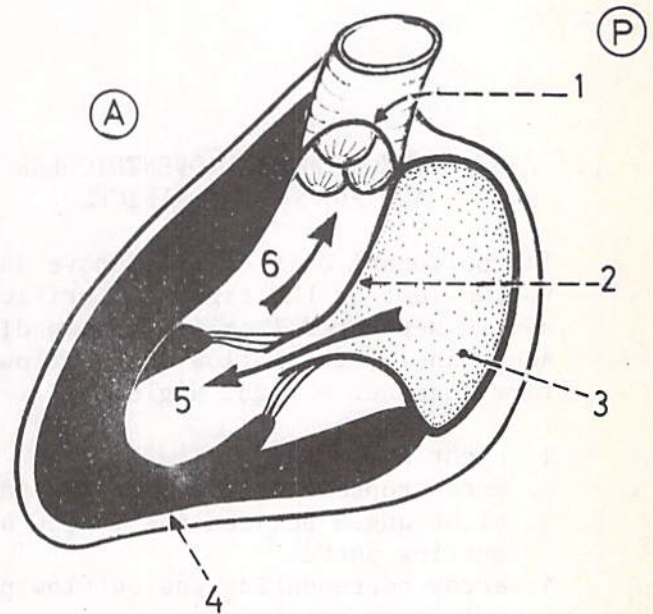


Fig.(335): PLANES OF THE LEFT ATRIOVENTRICULAR AND AORTIC ORIFICES

These 2 orifices are in direct contact with each other at the base of left ventricle, but they have different planes.

1. left atrioventricular orifice (has a vertical plane with the blood passing through it from behind forwards).
2. aortic orifice (has a horizontal plane with the blood passing through it from below upwards).

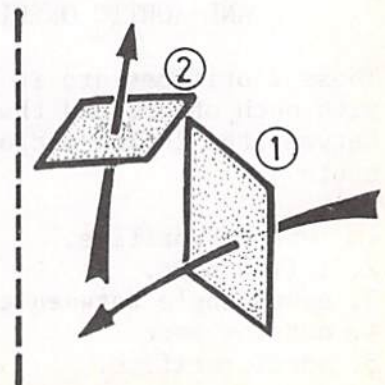


Fig.(336): INFLOW AND OUTFLOW PARTS OF BOTH VENTRICLES

The direction of blood flow in the right ventricle forms nearly a right angle between the inflow and outflow parts (1), while that in the left ventricle forms an acute angle (2).

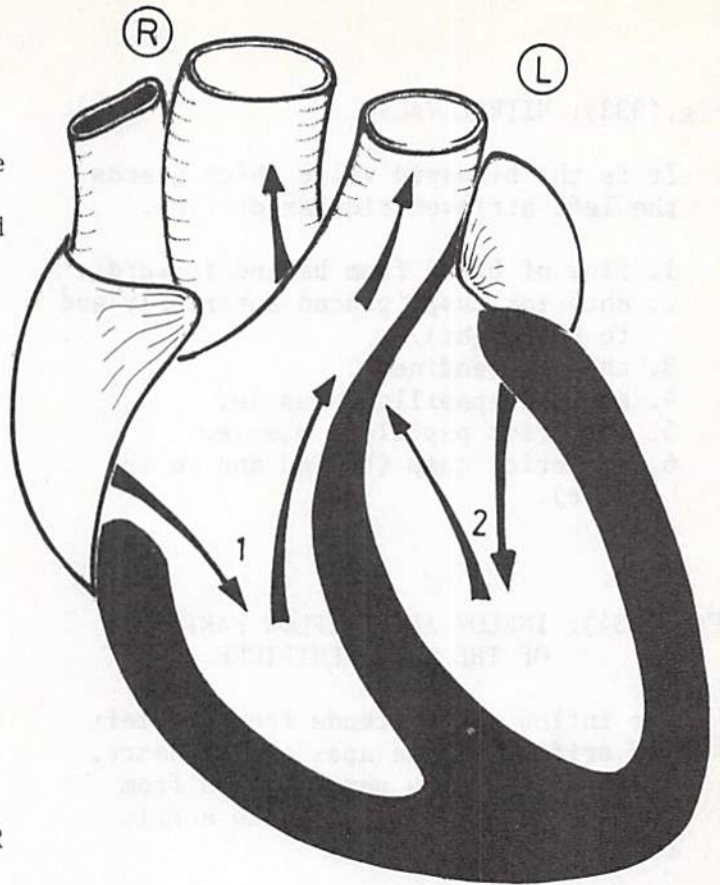


Fig.(337): THE RIGHT ATRIOVENTRICULAR AND PULMONARY ORIFICES

The pulmonary orifice lies above and to the left of the right A-V orifice and is separated from it by some distance. Accordingly, the inflow and outflow parts form together a right angle.

1. right A-V orifice.
2. arrow representing the inflow part.
3. right angle between the inflow and outflow parts.
4. arrow representing the outflow part.
5. pulmonary orifice.

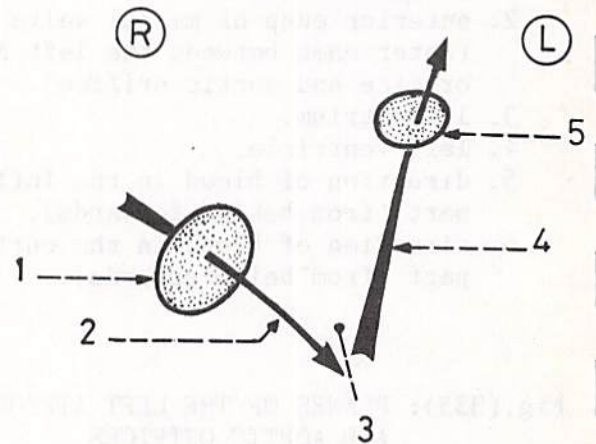


Fig.(338): THE LEFT ATRIOVENTRICULAR AND AORTIC ORIFICES

These 2 orifices are in direct contact with each other, and thus the angle between the inflow and outflow parts is acute.

1. left A-V orifice.
2. inflow part.
3. acute angle between the inflow and outflow parts.
4. outflow part.
5. aortic orifice.

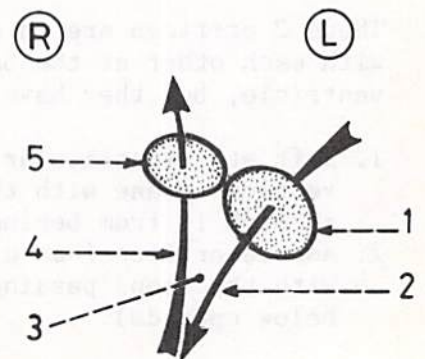


Fig.(339): POSITION OF THE 2 CUSPS
OF THE MITRAL VALVE

The anterior cusp is directed forwards and to the right intervening between the left A-V orifice and the aortic vestibule (*). The posterior cusp is directed backwards and to the left.

1. fibrous skeleton of the heart at the base of the ventricles (L.S.).
2. muscular part of interventricular septum.
3. membranous part of interventricular septum.
4. anterior papillary muscle.
5. anterior cusp of mitral valve.
6. arrow passing through the left A-V orifice.
7. posterior cusp of mitral valve.
8. posterior papillary muscle.

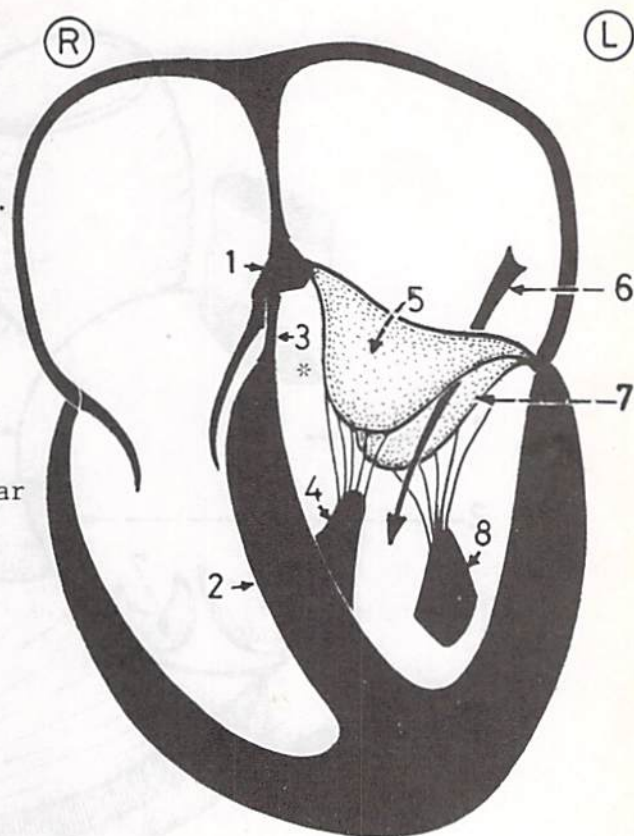
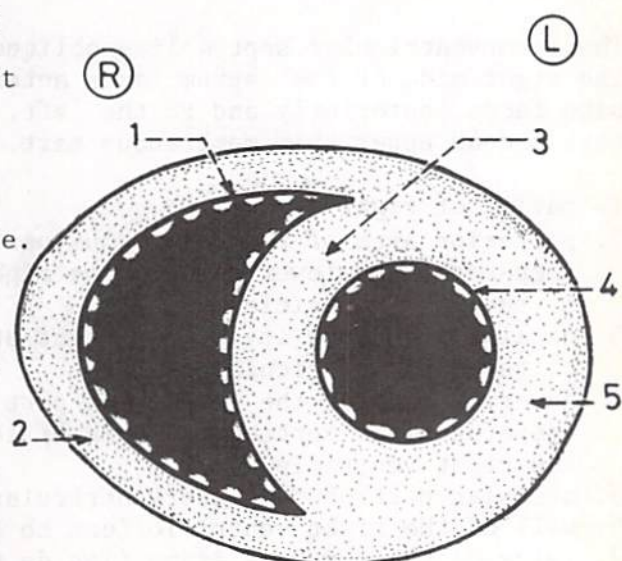


Fig.(340): SHAPE OF THE CAVITIES
OF THE 2 VENTRICLES
(T.S.)

The interventricular septum bulges into the right ventricle, thus having a right convex surface and a left concave surface. Accordingly, the left ventricle has a circular cavity in transverse section and the right ventricle has a semilunar cavity.

1. semilunar cavity of right ventricle.
2. wall of right ventricle (thin).
3. interventricular septum (bulges towards the right ventricle).
4. circular cavity of left ventricle.
5. wall of left ventricle (thick).



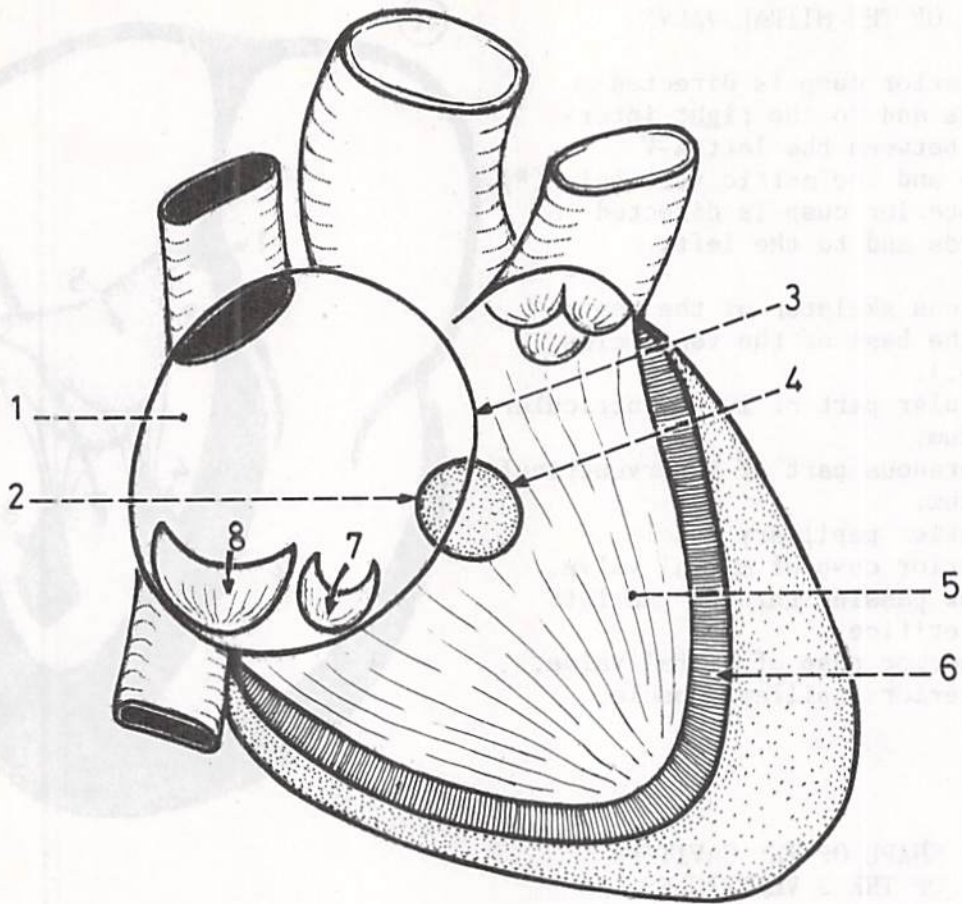


Fig.(341): INTERVENTRICULAR SEPTUM

The interventricular septum lies obliquely between the 2 ventricles so that the right side of the septum faces anteriorly and to the right, while its left side faces posteriorly and to the left. It consists of a lower thick muscular part and an upper thin membranous part.

1. cavity of right atrium.
2. posterior area of the membranous part of the interventricular septum (separates the lower part of the right atrium from the aortic vestibule of the left ventricle).
3. outline of the cavity of the right atrium (crossing the membranous part of the interventricular septum).
4. anterior area of the membranous part of the interventricular septum (separates the aortic vestibule of left ventricle from the upper part of the right ventricle).
5. muscular part of the interventricular septum (seen from the right side).
6. wall of the right ventricle (cut to expose the interventricular septum).
7. valve of the coronary sinus (inside the right atrium).
8. valve of inferior vena cava (inside the right atrium).

Fig.(342): POSITION OF THE 4 ORIFICES OF THE 2 VENTRICLES

The 4 orifices of the 2 ventricles (right A-V, left A-V, aortic and pulmonary) lie at the base of the 2 ventricles in the plane of the atrioventricular sulcus.

1. anterior cusp of aortic valve.
2. anterior cusp of tri-cuspid valve.
3. posterior cusp of tri-cuspid valve.
4. septal cusp of tricuspid valve.
5. right posterior cusp of aortic valve.
6. anterior cusp of mitral valve.
7. posterior cusp of mitral valve.
8. left posterior cusp of aortic valve.
9. posterior cusp of pulmonary valve.
10. left anterior cusp of pulmonary valve.
11. right anterior cusp of pulmonary valve.
12. anterior interventricular sulcus.

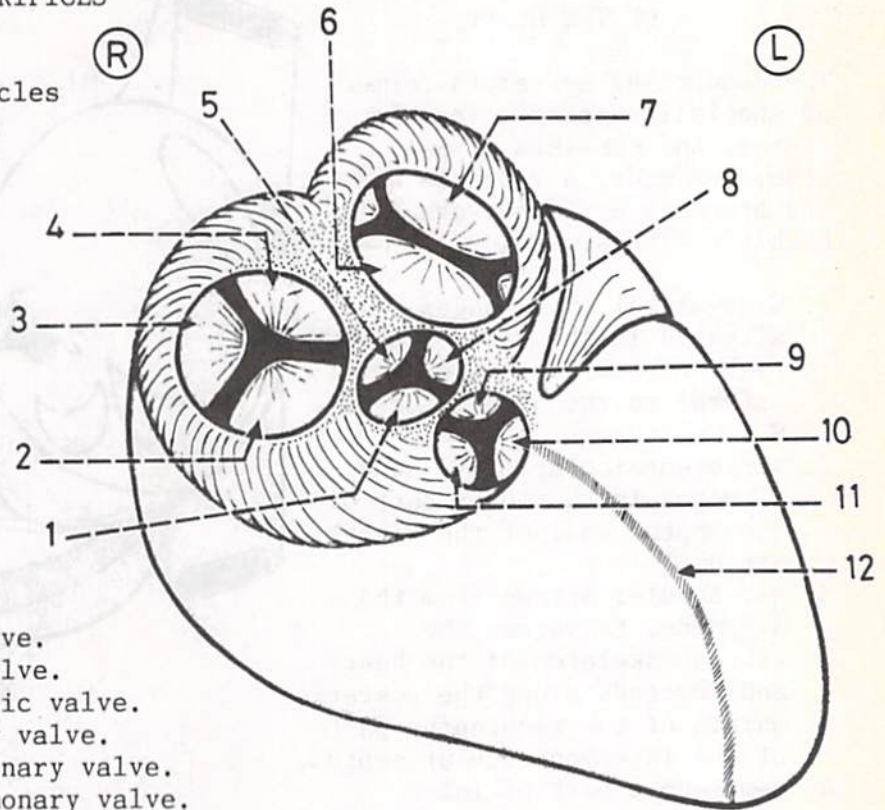
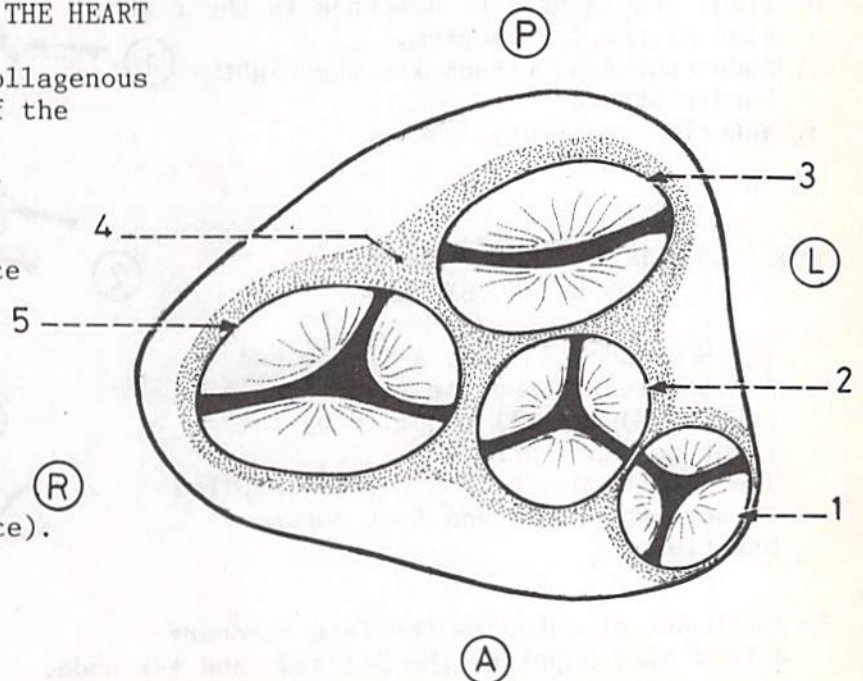


Fig.(343): FIBROUS SKELETON OF THE HEART

This is a dense framework of collagenous bundles situated at the base of the 2 ventricles. It surrounds the 4 orifices of the 2 ventricles.

1. pulmonary orifice (most anterior and is some distance away from the right A-V orifice).
2. aortic orifice (behind the pulmonary orifice and is in direct contact with the left A-V orifice).
3. left A-V orifice (to the left of the right A-V orifice).
4. fibrous skeleton of the heart (surrounding the 4 orifices).
5. right A-V orifice.



CONDUCTING SYSTEM OF THE HEART

Fig.(344): PARTS AND POSITION OF THE CONDUCTING SYSTEM OF THE HEART

The conducting system is formed of specialized cardiac muscle fibres, and consists of S-A node, A-V node, A-V bundle and its branches and a network of Purkinje fibres.

1. Sinu-atrial (S-A) node: situated in the wall of the right atrium just antero-lateral to the opening of the S.V.C.
2. Atrioventricular (A-V) node: situated in the lower part of the septal wall of the right atrium.
3. A-V bundle: arises from the A-V node, traverses the fibrous skeleton of the heart and descends along the posterior margin of the membranous part of the interventricular septum.
4. membranous part of interventricular septum.
5. left bundle branch: descends as several fascicles on the left side of the I.V. septum.
6. right bundle branch: descends in the right side of the I.V. septum.
7. moderator band (transmits the right bundle branch).
8. anterior papillary muscle.

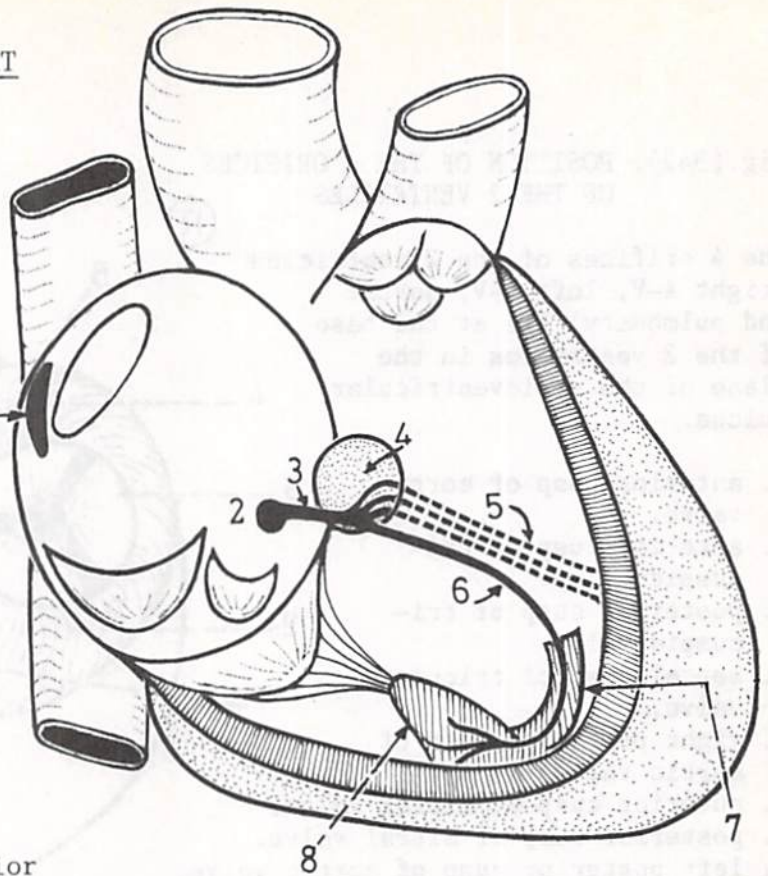
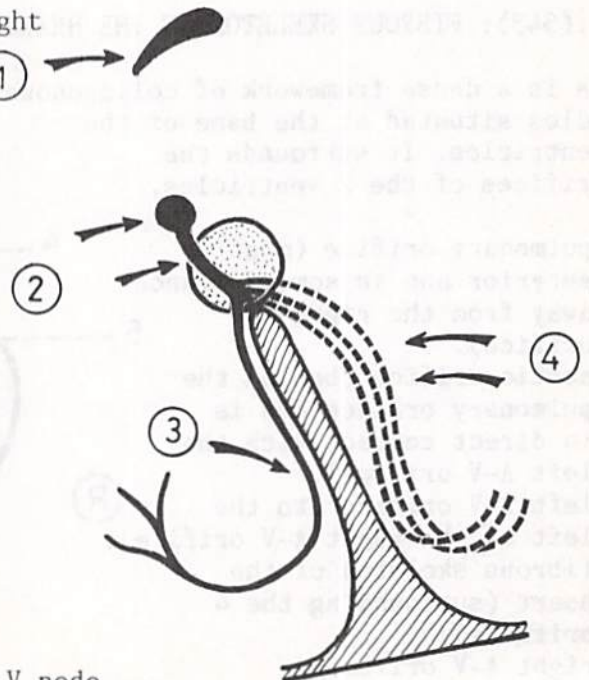


Fig.(345): BLOOD SUPPLY OF THE CONDUCTING SYSTEM

The S-A node (1), the A-V node and A-V bundle (2) and the right bundle branch (3) are all supplied by the right coronary artery. The left bundle branch (4) is supplied by both the right and left coronary arteries.



* In 20-40% of subjects the left coronary artery also supplies the S-A node and A-V node.

SURFACE ANATOMY OF THE HEART

Fig.(346): SURFACE ANATOMY OF THE STERNOCOSTAL SURFACE OF THE HEART

- (a) Upper border: is represented by a horizontal line extending from a point situated on the lower border of the left 2nd costal cartilage, $1\frac{1}{2}$ cm from the sternal margin (4) to a point on the upper border of the right 3rd costal cartilage, $1\frac{1}{2}$ cm from the sternal margin (1).
- (b) Right border: is represented by a vertical line extending from point (1) to a point on the 6th costal cartilage, $1\frac{1}{2}$ cm from the sternal margin (2).
- (c) Lower border: is represented by a horizontal line extending from point (2) to a point in the 5th intercostal space, 9 cm from the midline (3); point (3) represents the apex of the heart.
- (d) Left border: is represented by an oblique vertical line extending from point (3) to point (4).

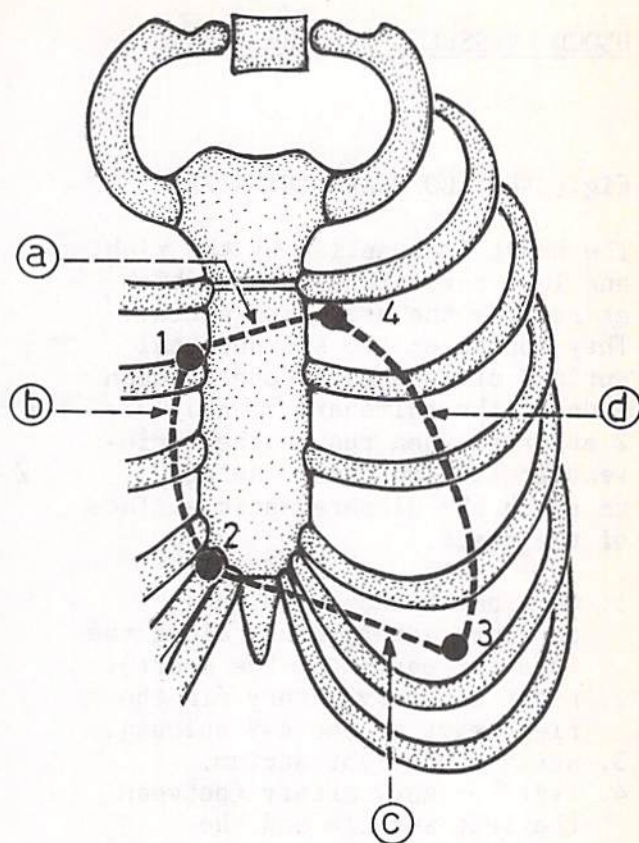
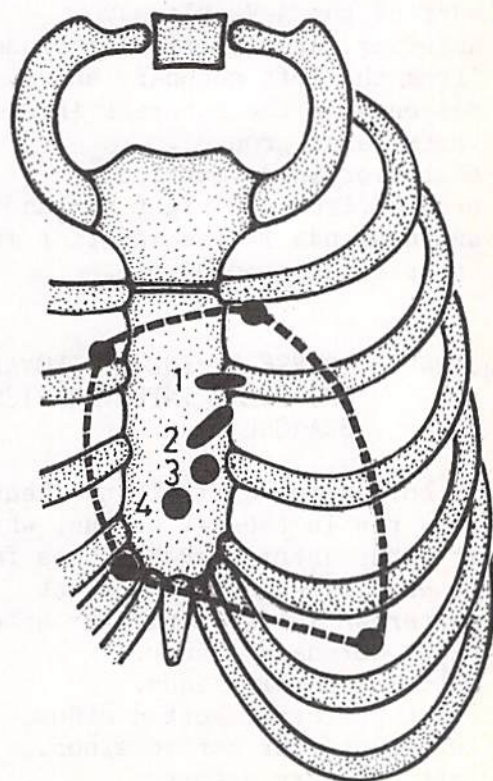


Fig.(347): SURFACE ANATOMY OF THE GREAT ORIFICES OF THE HEART

1. Pulmonary orifice: lies opposite the left 3rd costal cartilage, at its junction with the sternum.
2. Aortic orifice: lies opposite the left 3rd intercostal space, behind the left margin of the sternum.
3. Left A-V orifice: lies opposite the left 4th costal cartilage, behind the left half of the sternum.
4. Right A-V orifice: lies opposite the left 4th intercostal space, at the median plane.

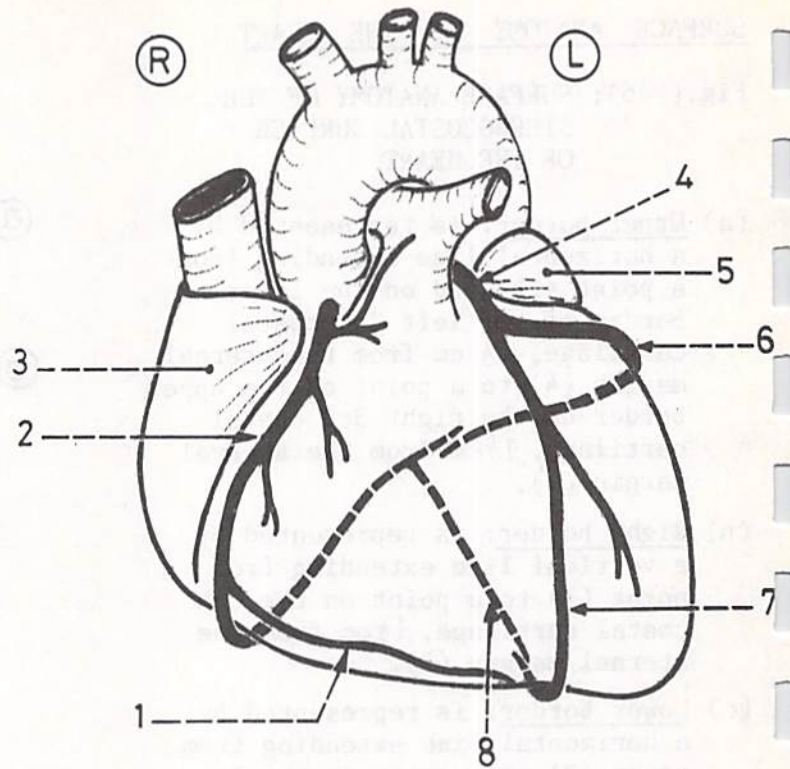


* Note that the 4 orifices of the heart lie along an oblique line extending from the left 3rd sternocostal junction to the right 6th sternocostal junction; this line corresponds to the atrioventricular (coronary) sulcus.

BLOOD VESSELS OF THE HEART

Fig.(348): CORONARY ARTERIES

The heart is supplied by the right and left coronary arteries which arise from the ascending aorta. They appear on the sternocostal surface of the heart, one on each side of the pulmonary trunk. The 2 arteries then run in the atrio-ventricular (coronary) sulcus to reach the diaphragmatic surface of the heart.



1. marginal branch of right coronary artery (runs along the inferior margin of the heart).
2. right coronary artery (in the right part of the A-V sulcus).
3. auricle of right atrium.
4. left coronary artery (between the left auricle and the pulmonary trunk).
5. left auricle.
6. circumflex artery (continuation of the left coronary in the left part of the A-V sulcus).
7. anterior interventricular branch (from the left coronary and descends in the anterior interventricular groove).
8. posterior interventricular branch (from the right coronary and descends in the inferior interventricular groove).

Fig.(349): COURSE OF THE 2 CORONARIES AND THEIR INTERVENTRICULAR BRANCHES

The 2 coronaries encircle the heart as they run in the A-V sulcus, while their interventricular branches form together a U-shaped arrangement.

1. posterior interventricular artery.
2. right coronary artery.
3. anterior aortic sinus.
4. right posterior aortic sinus.
5. left posterior aortic sinus.
6. left coronary artery.
7. anterior interventricular branch.
8. pulmonary orifice.

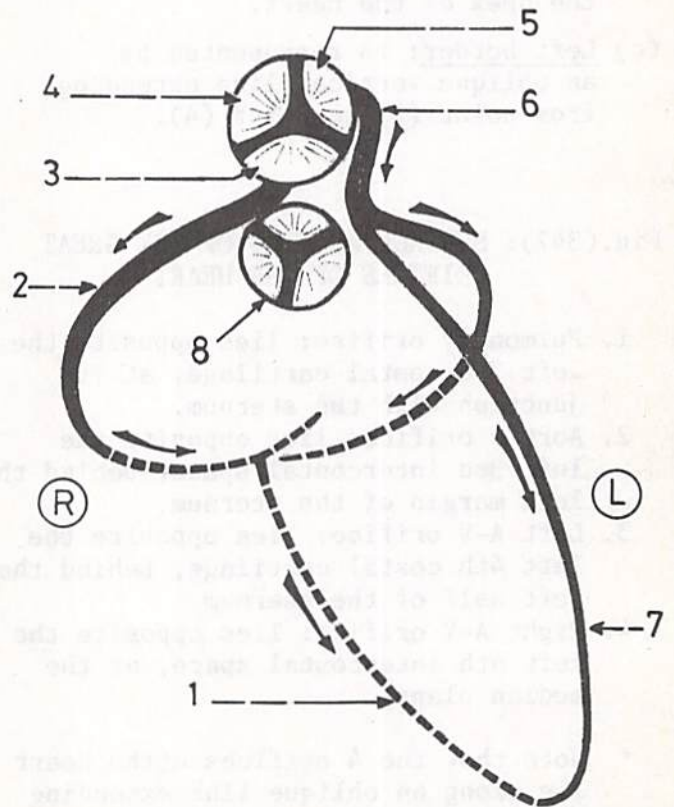


Fig.(350): DISTRIBUTION OF RIGHT CORONARY ARTERY

The right coronary artery supplies almost all the right ventricle, posterior 1/3 of the I.V. septum, whole right atrium and whole conducting system.

1. right coronary artery.
2. artery of S-A node.
3. atrial branches (to right atrium).
4. marginal artery (runs to the left along the inferior margin of the heart).
5. ventricular branches (to the right ventricle).
6. posterior interventricular artery (runs in the inferior interventricular groove and supplies the posterior 1/3 of the I.V. septum as well as the diaphragmatic surface of the heart).
7. anterior interventricular groove.
8. continuation of the right coronary artery on the back of the heart.
9. right conus artery (to the conus arteriosus of right ventricle).

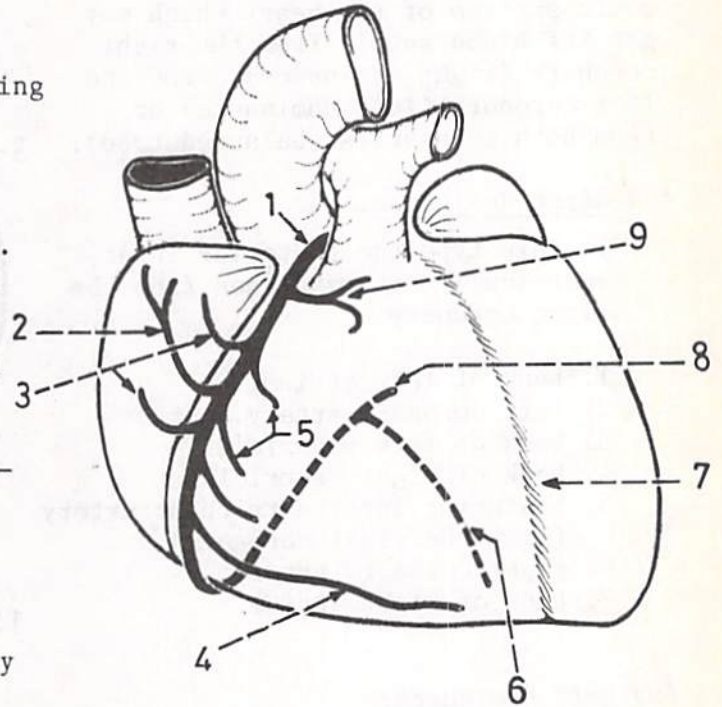


Fig.(351): DISTRIBUTION OF LEFT CORONARY ARTERY

The left coronary artery supplies almost all the left ventricle, anterior 2/3 of the I.V. septum, left atrium and a small part of the conducting system (left bundle branch and sometimes the S-A and A-V nodes).

1. left coronary artery.
2. circumflex artery (is the continuation of the left coronary artery which curves on the left border of the heart to reach the diaphragmatic surface).
3. ventricular branches (from the anterior interventricular artery to the left ventricle and a small strip of the right ventricle).
4. anterior interventricular artery (descends in the anterior interventricular groove and curves backwards a little to the right of the apex of the heart).
5. termination of the circumflex artery on the back of the heart.
6. left conus artery (anastomoses with the right conus artery).

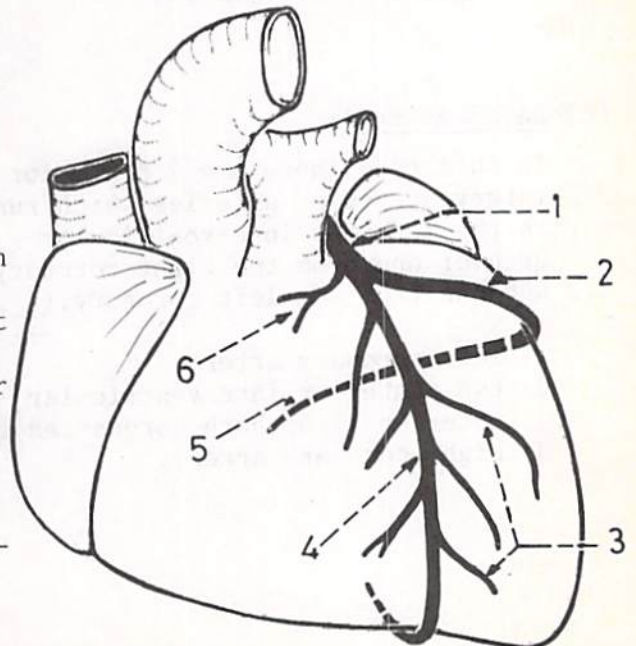


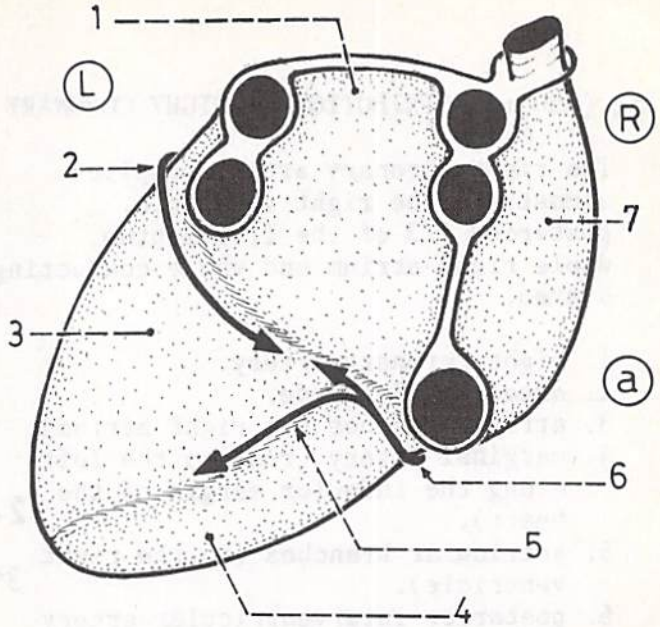
Fig.(352): VARIATIONS IN THE ARTERIAL SUPPLY OF THE HEART

These variations affect the diaphragmatic surface of the heart which may get its blood supply from the right coronary (right dominance), from the left coronary (left dominance) or from both coronaries (balanced type).

(a) Right dominance:

In this type the posterior inter-ventricular artery arises from the right coronary.

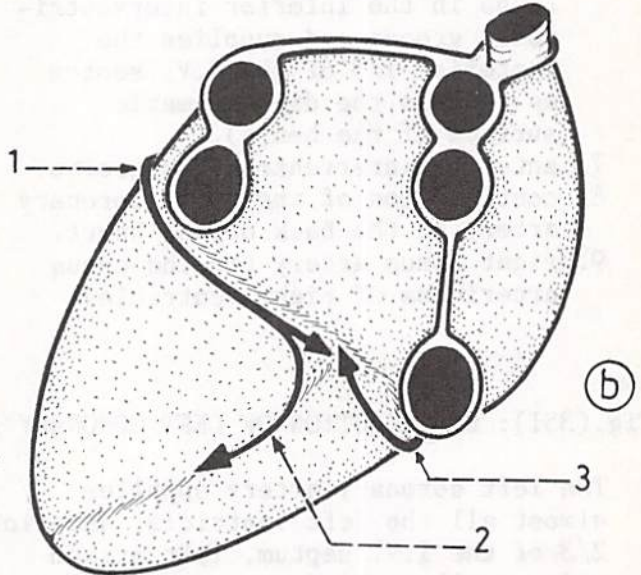
- 1. back of left atrium.
- 2. left coronary artery.
- 3. back of left ventricle.
- 4. back of right ventricle.
- 5. posterior interventricular artery (from the right coronary).
- 6. right coronary artery.
- 7. back of right atrium.



(b) Left dominance:

In this type the posterior inter-ventricular artery arises from the left coronary.

- 1. left coronary artery.
- 2. posterior interventricular artery.
- 3. right coronary artery.



(c) Balanced type:

In this type there are 2 posterior inter-ventricular arteries which run in the inferior interventricular groove: one from the right coronary and one from the left coronary.

- 1. left coronary artery.
- 2. two posterior interventricular arteries (from both coronaries).
- 3. right coronary artery.

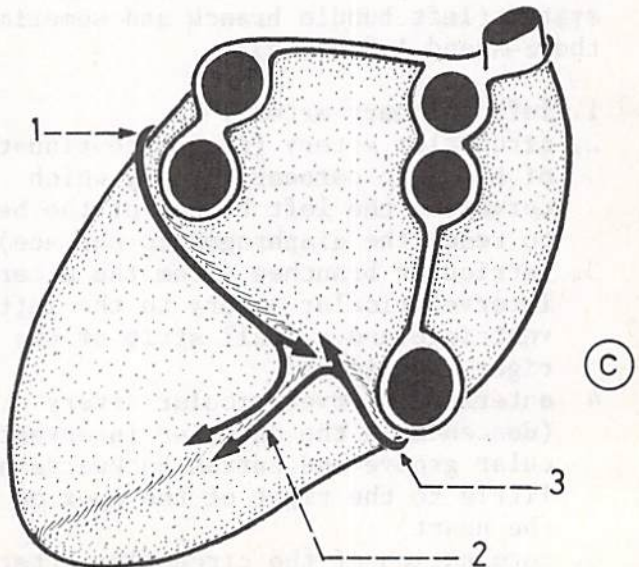
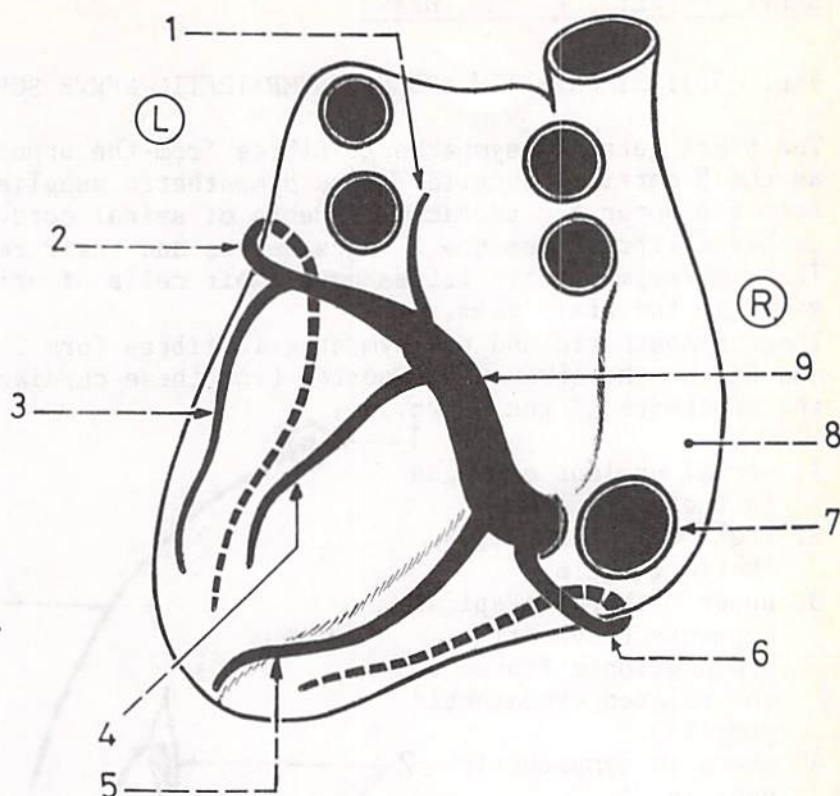


Fig.(353): CORONARY SINUS AND ITS TRIBUTARIES

Most of the venous drainage of the heart is through the coronary sinus which is a wide venous channel situated in the posterior part of the A-V sulcus on the back of the heart.

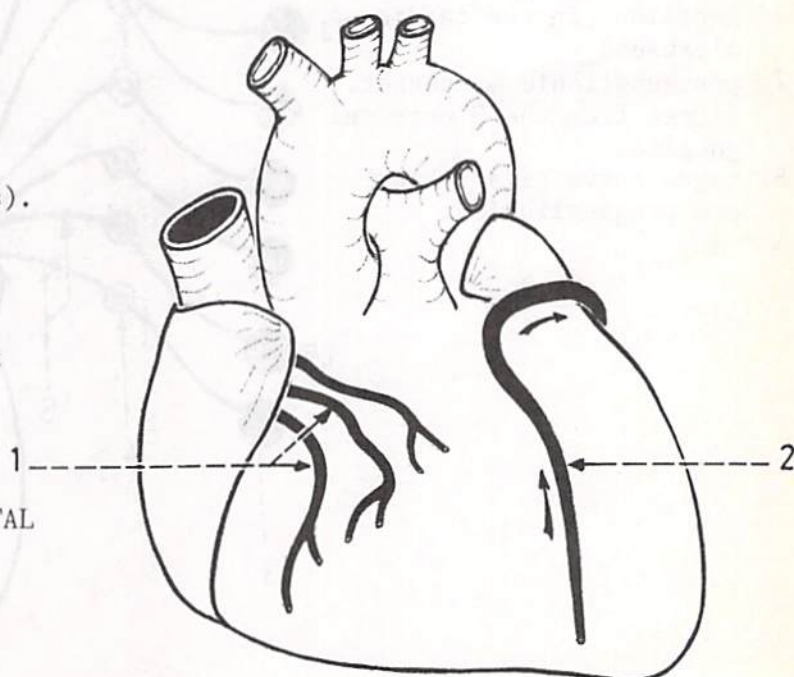
The coronary sinus has the following tributaries:
great, middle and small cardiac veins, posterior vein of left ventricle and oblique vein of left atrium.



1. oblique vein of left atrium (on the back of left atrium).
2. great cardiac vein (joins the left end of the coronary sinus).
3. left marginal vein (ascends along the left margin of the heart and ends in the great cardiac vein).
4. posterior vein of left ventricle (runs on the diaphragmatic surface of the left ventricle).
5. middle cardiac vein (runs in the inferior I.V. groove).
6. small cardiac vein (curves round the right border of the heart and opens into the right end of the coronary sinus).
7. opening of inferior vena cava.
8. right atrium.
9. coronary sinus (runs in the posterior part of the coronary sulcus and opens into the right atrium close to the opening of the inferior vena cava).

Fig.(354): VEINS ON THE STERNOCOSTAL SURFACE OF THE HEART

These are the anterior cardiac veins and the great cardiac vein.



1. anterior cardiac veins (open into the right atrium).
2. great cardiac vein (runs in the anterior interventricular groove and joins the coronary sinus).

NERVE SUPPLY OF THE HEART

Fig.(355): SYMPATHETIC AND PARASYMPATHETIC NERVE SUPPLY OF THE HEART

The heart gets its sympathetic fibres from the upper thoracic ganglia as well as the 3 cervical ganglia. These sympathetic ganglia receive preganglionic fibres from the upper 5 thoracic segments of spinal cord. The heart also gets parasympathetic fibres from the 2 vagus nerves and their recurrent laryngeal branches. These parasympathetic fibres have their cells of origin in the dorsal nucleus of vagus in the brain stem.

These sympathetic and parasympathetic fibres form 2 cardiac plexuses situated below and behind the arch of the aorta. From these cardiac plexuses nerve fibres enter the substance of the heart.

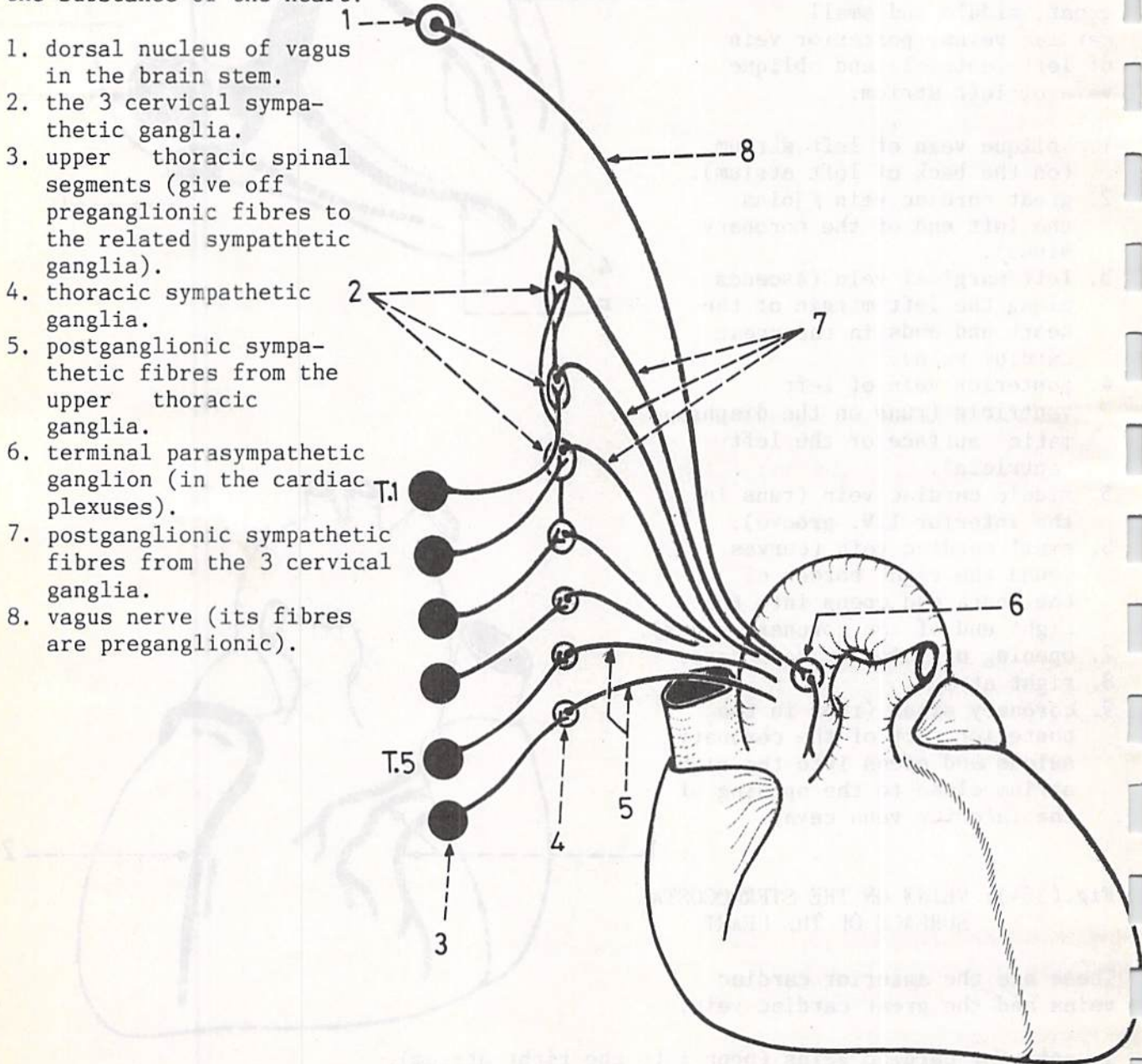
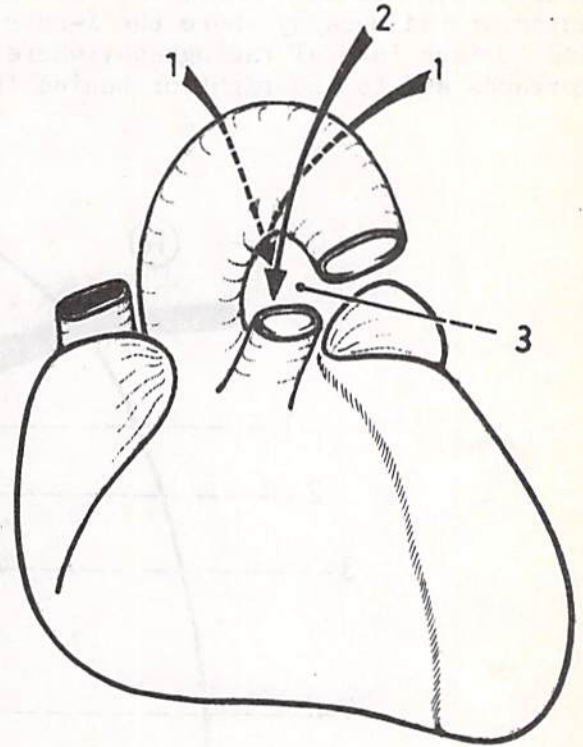


Fig.(356): CARDIAC PLEXUSES OF THE HEART

There are 2 cardiac plexuses (superficial and deep). The superficial cardiac plexus lies just below the arch of the aorta, and is formed by the superior cervical cardiac branch of left sympathetic trunk and the inferior cervical cardiac branch of left vagus. The deep cardiac plexus lies on the bifurcation of the trachea behind the arch of the aorta, and is formed by the remaining sympathetic and parasympathetic cardiac branches of both sides.

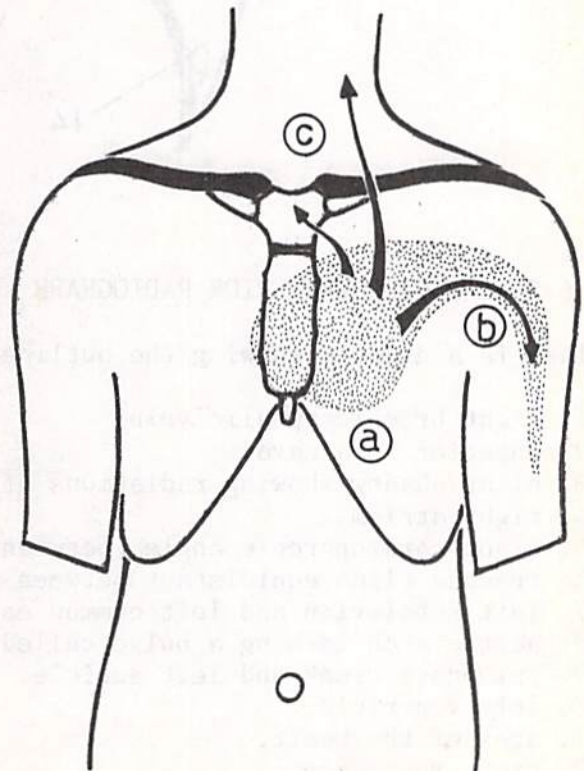


1. branches forming the deep cardiac plexus (behind the arch of the aorta).
2. fibres to the superficial cardiac plexus (cross superficial to the arch of the aorta).
3. site of the superficial cardiac plexus (at the concavity of the arch of the aorta).

Fig.(357): REFERRED PAIN FROM THE HEART

Pain from the heart (angina pectoris) is conveyed through afferent sympathetic fibres (and may be through vagal fibres also) to be felt in the anterior wall of the chest in front of the heart (precordial area), in the left upper limb and sometimes at the left angle of the jaw.

- (a) precordial area where most of the pain from the heart is felt.
- (b) pain referred to the left upper limb.
- (c) pain referred upwards towards the jaw (in some cases).



RADIOGRAPHY OF THE CHEST

There are 2 standard positions for radiography of the chest. These are postero-anterior radiography where the X-rays traverse the chest from behind forwards, and oblique lateral radiography where the X-rays pass obliquely from behind forwards and to the right or behind forwards and to the left.

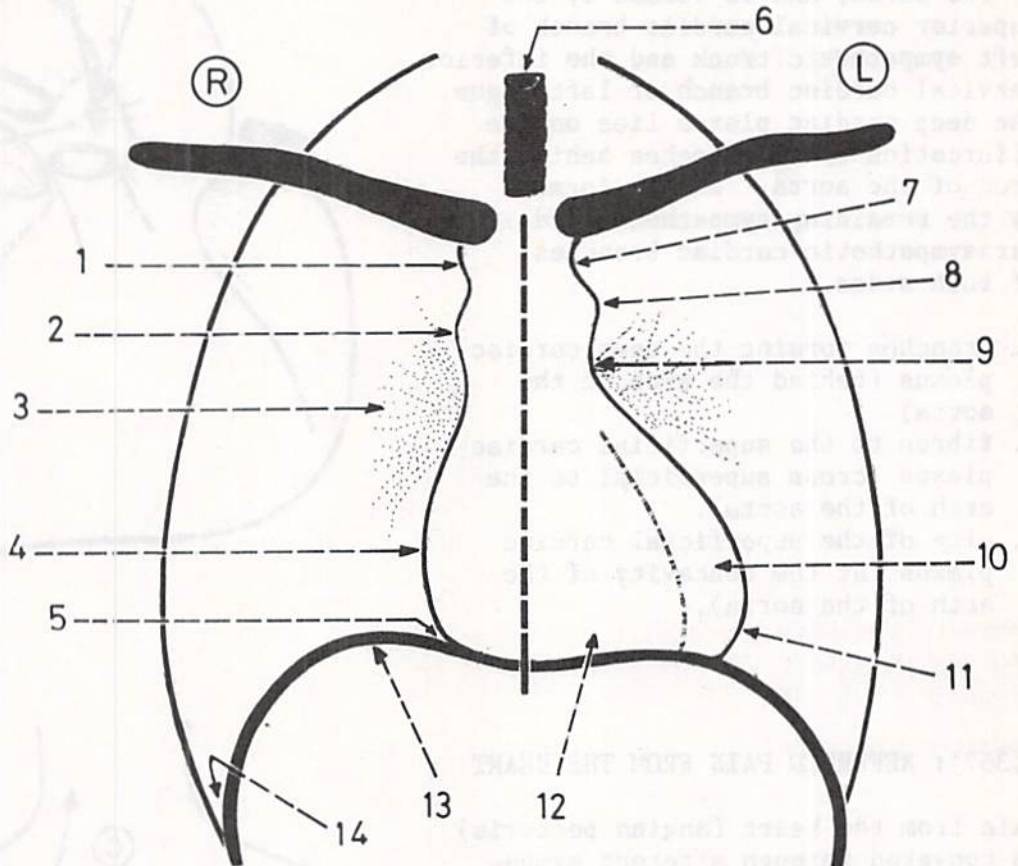


Fig.(358): POSTERO-ANTERIOR RADIOGRAPH OF THE HEART

This is a diagram showing the outline of the heart as seen in X-ray.

1. right brachiocephalic vein.
2. superior vena cava.
3. hilar shadow showing radiations of the branches of the pulmonary vessels.
4. right atrium.
5. right cardiophrenic angle (between the heart and diaphragm).
6. trachea (lies equidistant between the medial ends of the 2 clavicles).
7. left subclavian and left common carotid arteries.
8. aortic arch forming a bulge called aortic knuckle.
9. pulmonary trunk and left auricle.
10. left ventricle.
11. apex of the heart.
12. right ventricle.
13. right dome of diaphragm.
14. costodiaphragmatic angle (between the diaphragm and chest wall).

Fig.(359): OBLIQUE LATERAL RADIOGRAPH
OF THE HEART

This is a diagram showing the outline of the heart as seen in X-ray (side view). The heart shadow is seen very close to the sternum anteriorly, but is separated from the vertebral column behind by the retrocardiac space which contains the descending aorta and oesophagus.

1. anterior mediastinum.
2. heart shadow.
3. diaphragm.
4. retrocardiac space (posterior mediastinum).
5. oesophagus (only seen when it contains barium sulphate).

* In the right oblique view, the heart shadow is made up of the right ventricle anteriorly and the right atrium posteriorly.

* In the left oblique view, the heart shadow is made up of the left ventricle anteriorly and the left atrium posteriorly.

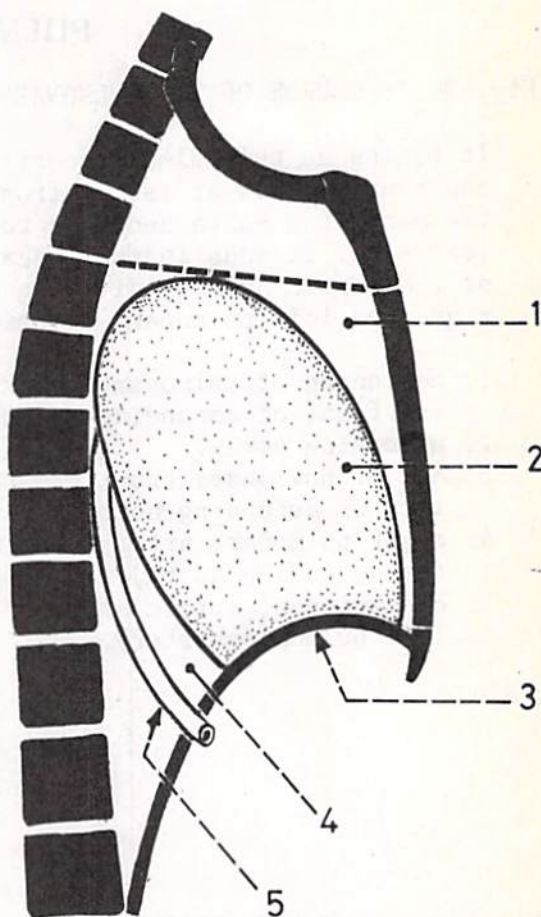
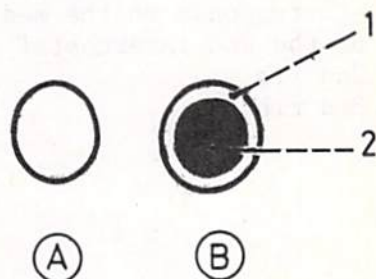


Fig.(360): APPEARANCE OF A BRONCHUS AND A BLOOD
VESSEL IN A RADIOGRAPH WHEN THEY ARE
SEEN END-ON

- (A) Blood vessel seen end-on: appears as a homogeneous white shadow because it contains blood which is slightly opaque to X-ray.
- (B) Bronchus seen end-on: appears as a white ring representing the wall of the bronchus with a dark shadow inside representing the air which is translucent to X-ray.

1. white rim (wall).
2. dark lumen (cavity).



PULMONARY TRUNK

Fig.(361): COURSE OF THE PULMONARY TRUNK

It begins at the pulmonary orifice, and runs upwards at 1st in front of the ascending aorta and then to its left side. It ends in the concavity of the aortic arch by dividing into right and left pulmonary arteries.

1. beginning of pulmonary trunk (in front of ascending aorta).
2. ascending aorta.
3. end of pulmonary trunk (to the left of ascending aorta).
4. right pulmonary artery (behind the ascending aorta).
5. concavity of aortic arch.
6. left pulmonary artery.

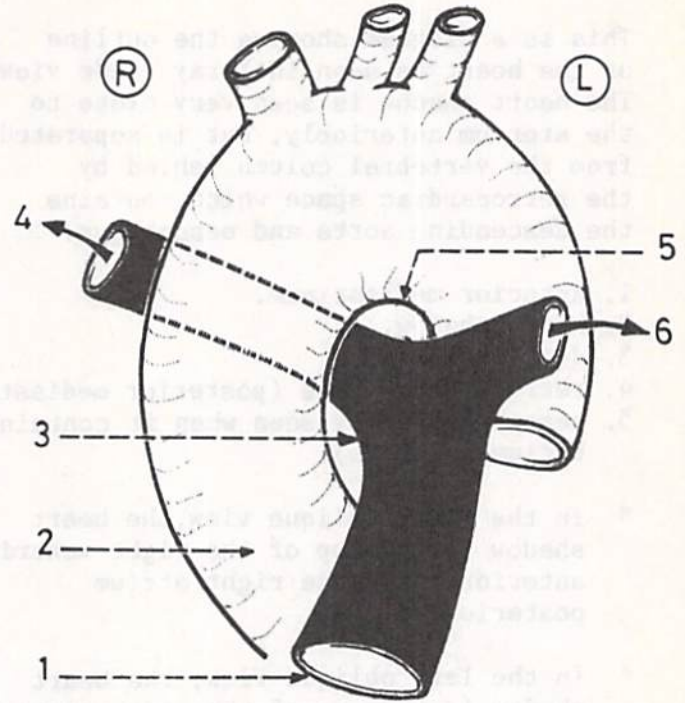


Fig.(362): SURFACE ANATOMY OF THE PULMONARY TRUNK

It is represented by a vertical line along the left margin of the sternum extending from the left 3rd sternocostal junction to the left 2nd sternocostal junction.

1. line of the pulmonary trunk (corresponds to the medial end of the 2nd intercostal space).
2. 2nd rib.
3. 3rd rib.

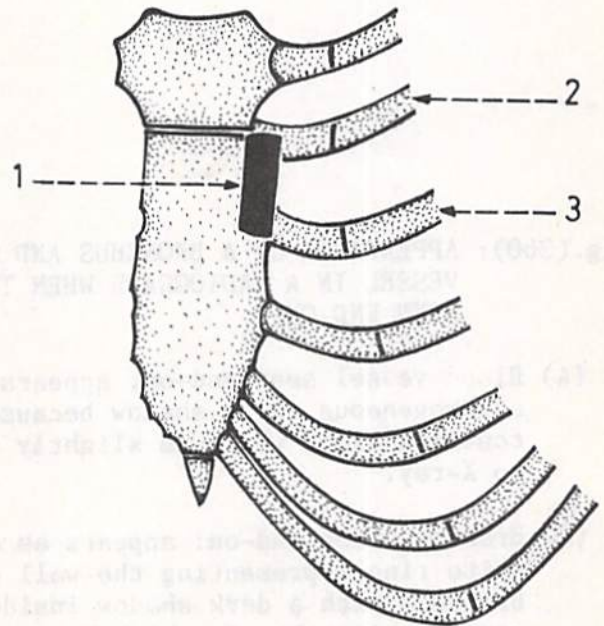


Fig.(363): RELATION OF THE PERICARDIUM TO THE PULMONARY TRUNK

The whole pulmonary trunk lies within the pericardial cavity where it is surrounded together with the ascending aorta by a sheath from the visceral layer of serous pericardium.

1. line of attachment of fibrous pericardium to the end of ascending aorta.
2. ascending aorta (within the pericardial cavity).
3. visceral layer of serous pericardium covering the ascending aorta.
4. pulmonary trunk.
5. visceral layer of serous pericardium covering the pulmonary trunk.
6. line of attachment of fibrous pericardium to the end of pulmonary trunk.

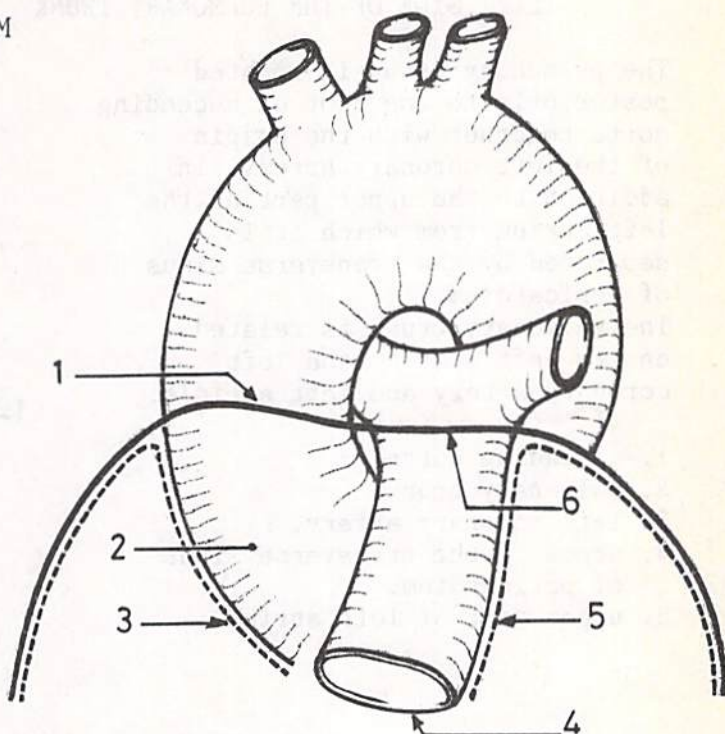


Fig.(364): PULMONARY TRUNK AND ASCENDING AORTA WITHIN A TUBE OF SEROUS PERICARDIUM

1. arch of the aorta (outside the pericardium).
2. tube of serous pericardium surrounding the ascending aorta and pulmonary trunk together.
3. ascending aorta.
4. pulmonary trunk.
5. left pulmonary artery (outside the pericardial cavity).

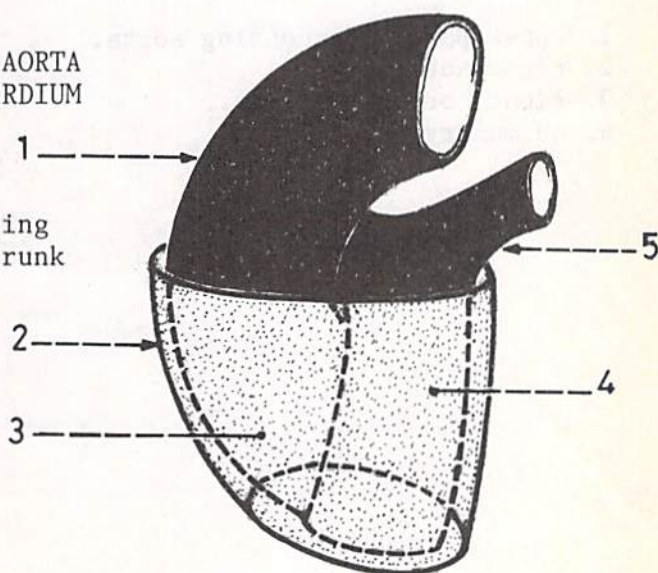


Fig.(365): RELATIONS BEHIND AND TO THE
LEFT SIDE OF THE PULMONARY TRUNK

The pulmonary trunk is related posteriorly to the root of ascending aorta together with the origin of the left coronary artery, in addition to the upper part of the left atrium from which it is separated by the transverse sinus of pericardium.

The pulmonary trunk is related on its left side to the left coronary artery and left auricle.

1. ascending aorta.
2. pulmonary trunk.
3. left coronary artery.
4. arrow in the transverse sinus of pericardium.
5. upper part of left atrium.

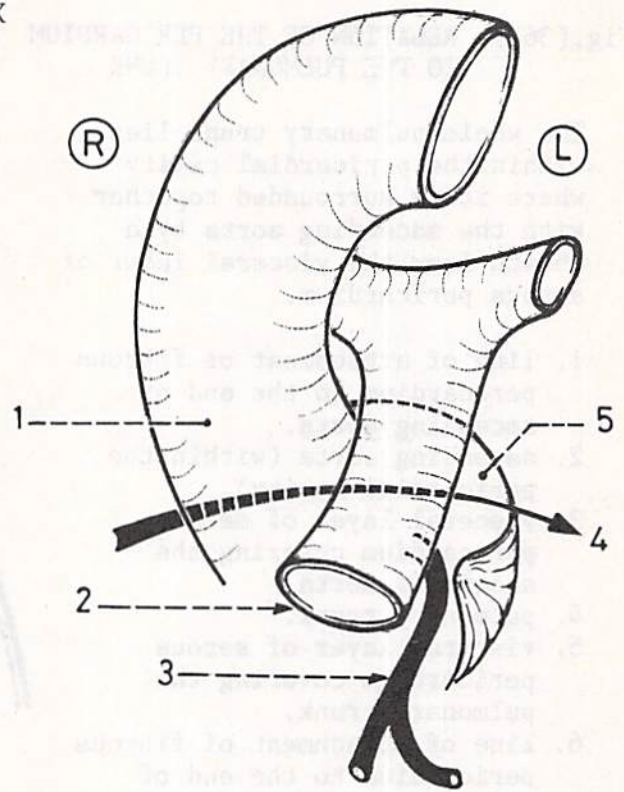
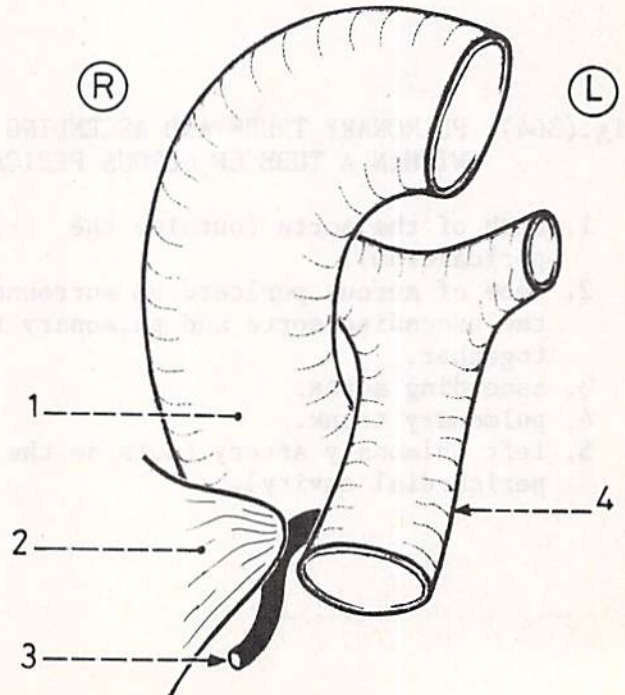


Fig.(366): RELATIONS ON THE RIGHT SIDE
OF THE PULMONARY TRUNK

These are the right coronary artery, right auricle and upper part of ascending aorta.

1. upper part of ascending aorta.
2. right auricle.
3. right coronary artery.
4. pulmonary trunk.



PULMONARY ARTERIES

Fig.(367): COURSE OF THE PULMONARY ARTERIES

The right pulmonary artery runs horizontally above the 2 atria and behind the ascending aorta and superior vena cava to enter the root of the right lung.

The left pulmonary artery runs obliquely upwards and to the left in front of the left bronchus and descending aorta to enter the root of the left lung.

1. right pulmonary artery.
2. right bronchus (behind the artery).
3. left pulmonary artery.
4. beginning of descending aorta.
5. left bronchus (behind the left pulmonary artery).

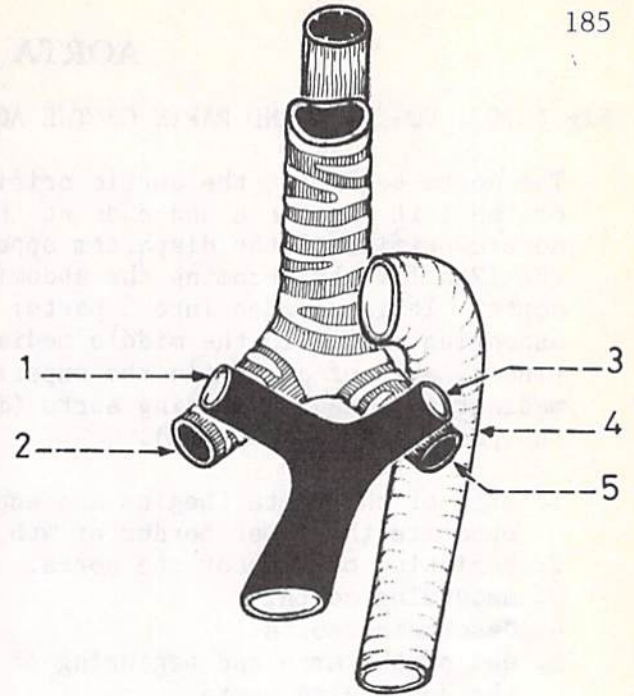


Fig.(368): STRUCTURES IN FRONT OF THE RIGHT PULMONARY ARTERY

These are the ascending aorta and superior vena cava.

1. right pulmonary artery (runs a horizontal course).
2. superior vena cava.
3. ascending aorta.

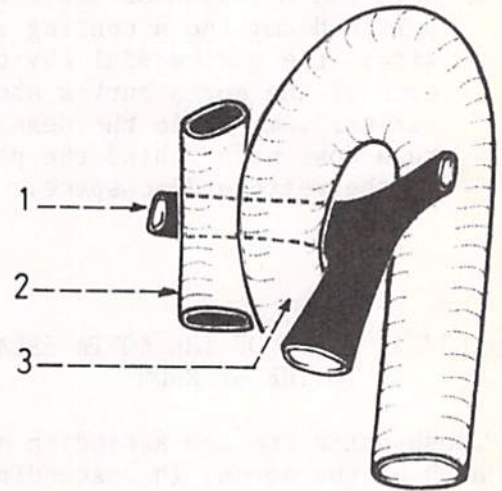
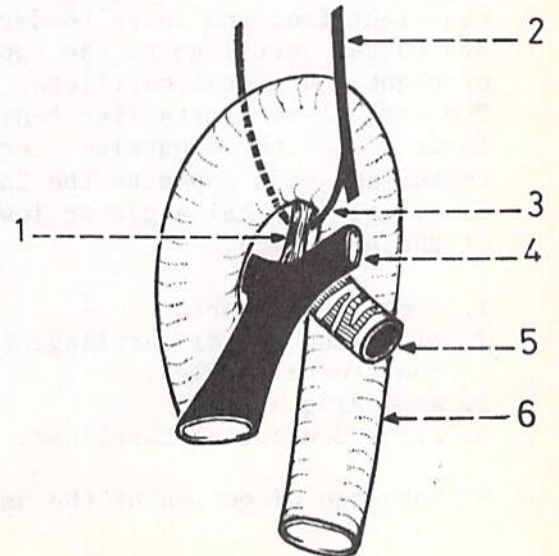


Fig.(369): STRUCTURES RELATED TO THE LEFT PULMONARY ARTERY

The artery runs in front of the left bronchus and descending aorta, and is connected to the concavity of the arch of the aorta by the ligamentum arteriosum.

1. ligamentum arteriosum.
2. left vagus nerve.
3. left recurrent laryngeal nerve hooking round the ligamentum arteriosum.
4. left pulmonary artery.
5. left bronchus.
6. descending aorta.



AORTA

Fig.(370): POSITION AND PARTS OF THE AORTA

The aorta begins at the aortic orifice of the left ventricle and ends at the aortic orifice of the diaphragm opposite the 12th T.V. by becoming the abdominal aorta. It is divided into 3 parts: ascending aorta (in the middle mediastinum), arch of aorta (in the superior mediastinum) and descending aorta (in the posterior mediastinum).

1. arch of the aorta (begins and ends opposite the lower border of 4th T.V.).
2. beginning of arch of the aorta.
3. ascending aorta.
4. descending aorta.
5. end of the arch and beginning of the descending aorta.

* Note the relation of the aorta to the pericardium: the ascending aorta lies within the pericardial cavity, the arch of the aorta curves above the pericardium, while the descending aorta runs downwards behind the pericardium in the retrocardiac space.

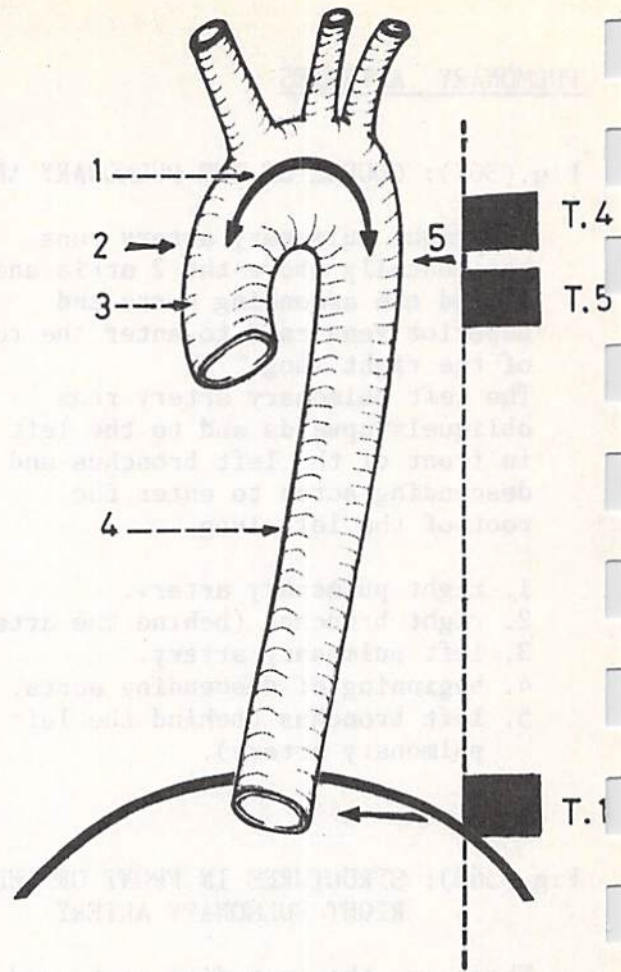
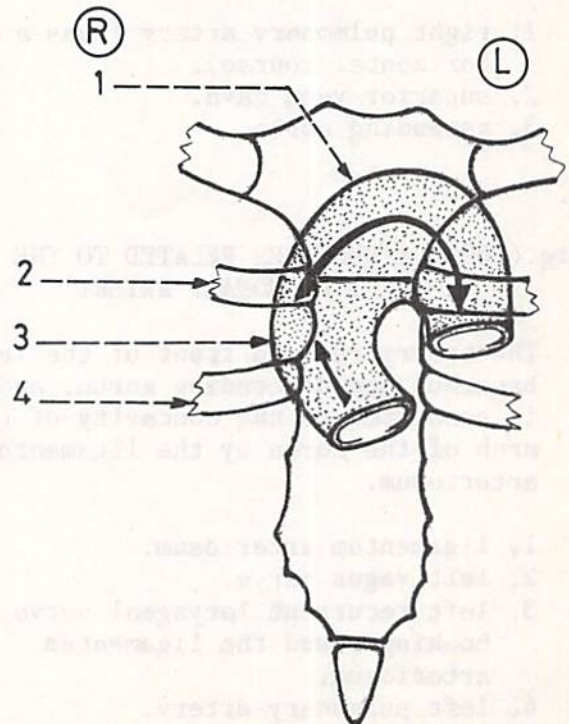


Fig.(371): PARTS OF THE AORTA RELATED TO THE STERNUM

These parts are the ascending aorta and arch of the aorta. The ascending aorta lies behind the upper part of the body of the sternum extending upwards and to the right from the lower border of left 3rd costal cartilage to the upper border of right 2nd costal cartilage. The arch of the aorta lies behind the lower 1/2 of the manubrium sterni. It begins and ends opposite the 2nd costal cartilage (sternal angle or lower border of the 4th T.V.).

1. arch of the aorta.
2. right 2nd costal cartilage (opposite the sternal angle).
3. ascending aorta.
4. right 3rd costal cartilage.

* Note the direction of the ascending aorta upwards and to the right.



ASCENDING AORTA

Fig.(372): DILATATIONS AND BRANCHES OF ASCENDING AORTA

The ascending aorta shows 3 dilatations at its beginning opposite the 3 aortic cusps called aortic sinuses (one anterior and 2 posterior). It also shows a dilatation in the upper part of its right wall called bulb of the aorta.

The ascending aorta gives off the 2 coronary arteries which arise from the aortic sinuses.

1. end of the ascending aorta and beginning of the arch (opposite the sternal angle).
2. bulb of the aorta (a dilatation in the lateral wall of the ascending aorta).
3. direction of the ascending aorta (upwards, forwards and to the right).
4. right posterior aortic sinus.
5. right coronary artery (arises from the anterior aortic sinus).
6. anterior aortic sinus.
7. left posterior aortic sinus.
8. left coronary artery (arises from the left posterior aortic sinus).
9. descending aorta.
10. end of the arch and beginning of descending aorta (opposite lower border of 4th T.V.).
11. arch of the aorta.

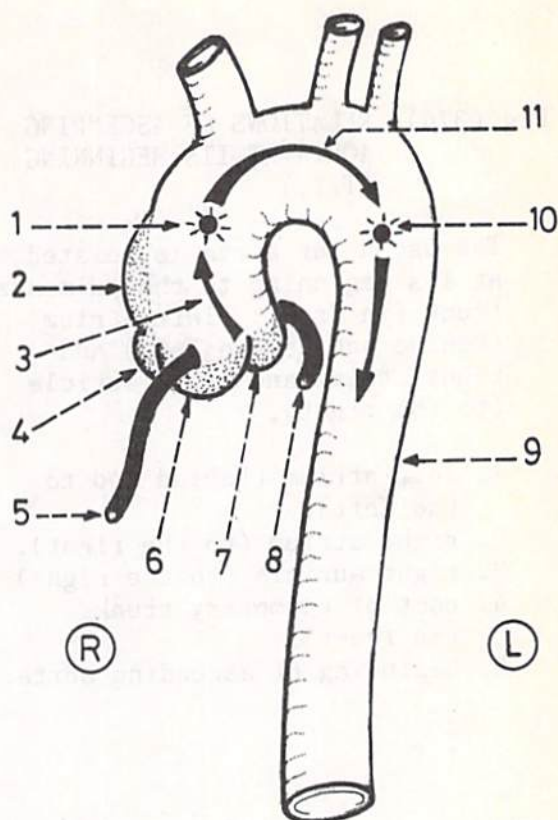


Fig.(373): ANTERIOR RELATIONS OF ASCENDING AORTA

The ascending aorta lies completely within the pericardial cavity and is related anteriorly at its beginning to the root of pulmonary trunk and right auricle.

1. right auricle.
2. ascending aorta.
3. right pulmonary artery (behind the ascending aorta).
4. root of pulmonary trunk.

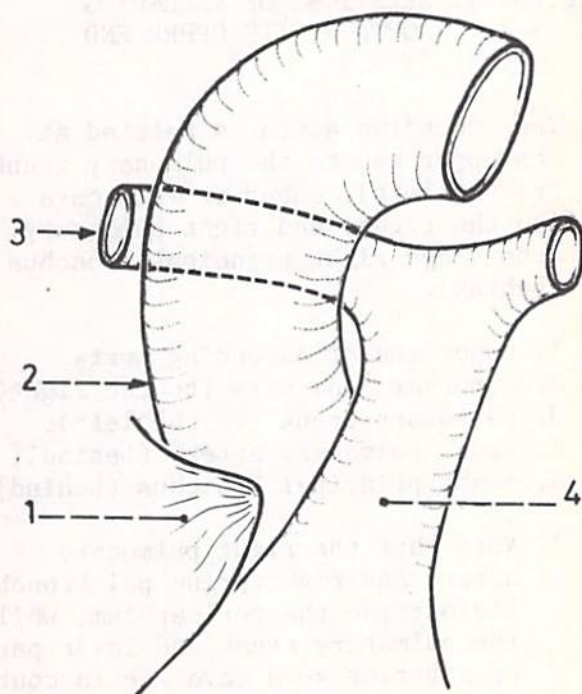


Fig.(374): RELATIONS OF ASCENDING AORTA AT ITS BEGINNING (T.S.)

The ascending aorta is related at its beginning to the pulmonary trunk (in front), left atrium (behind and to the left) and right atrium and right auricle (to the right).

1. left atrium (behind and to the left).
2. right atrium (to the right).
3. right auricle (to the right).
4. root of pulmonary trunk (in front).
5. beginning of ascending aorta.

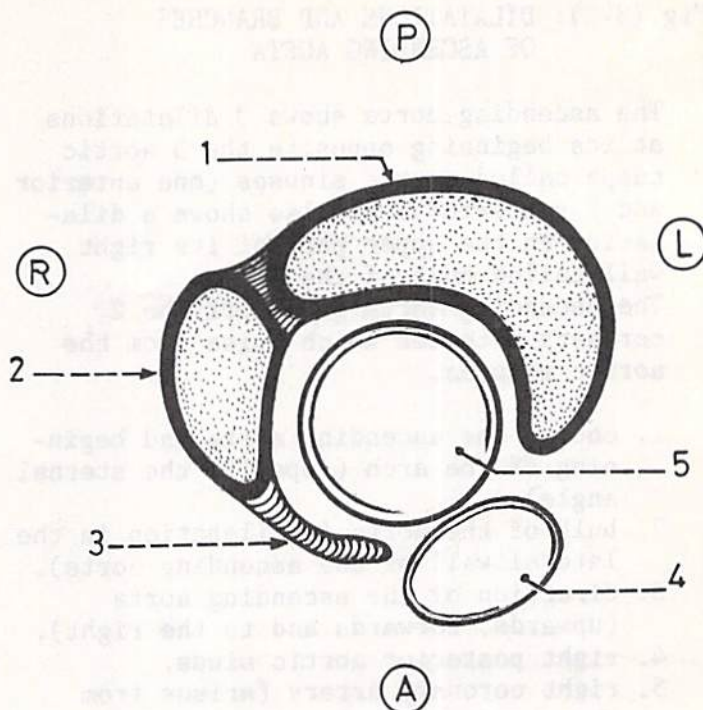
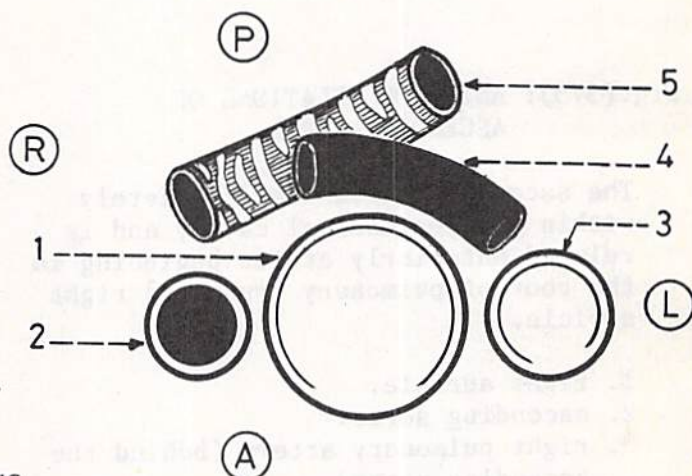


Fig.(375): RELATIONS OF ASCENDING AORTA AT ITS UPPER END (T.S.)

The ascending aorta is related at its upper end to the pulmonary trunk (to the left), superior vena cava (to the right) and right pulmonary artery and right principal bronchus (behind).

1. upper end of ascending aorta.
2. superior vena cava (to the right).
3. pulmonary trunk (to the left).
4. right pulmonary artery (behind).
5. right principal bronchus (behind).



* Note that the right pulmonary artery and right principal bronchus lie outside the pericardium, while the pulmonary trunk and lower part of superior vena cava lie in contact with the ascending aorta inside the pericardium.

ARCH OF THE AORTA

Fig.(376): COURSE AND BRANCHES OF THE ARCH OF THE AORTA

The arch of the aorta lies in the superior mediastinum behind the lower 1/2 of the manubrium sterni. It has 2 curves, the 1st of which runs upwards and to the left in front of the lower end of the trachea while the 2nd curve runs backwards and downwards on the left side of the trachea. The arch begins at the level of the 2nd right sternocostal junction, and ends at the lower border of the 4th T.V. It gives off 3 branches from its upper convex border (brachiocephalic, left common carotid and left subclavian).

1. brachiocephalic artery.
2. beginning of the arch of aorta.
3. right principal bronchus.
4. left principal bronchus.
5. end of the arch of aorta.
6. left subclavian artery.
7. left common carotid artery.
8. trachea.

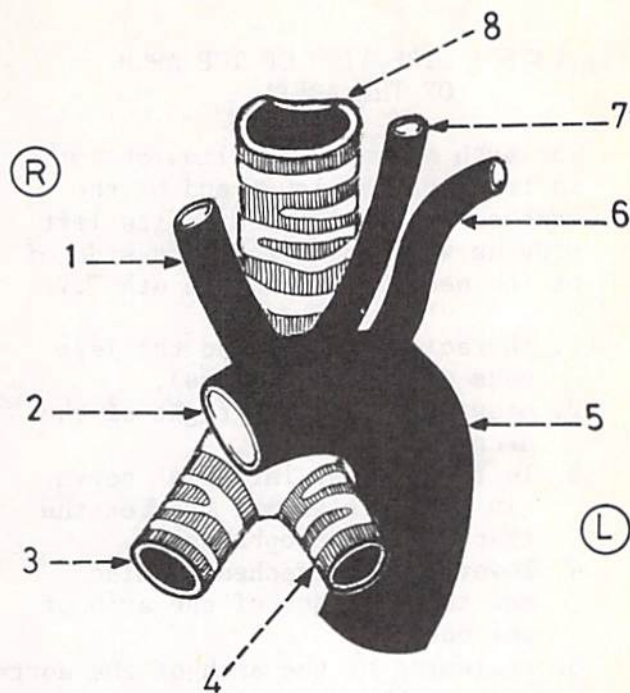


Fig.(377): CURVES OF THE ARCH OF THE AORTA

The arch of the aorta forms 2 curves in relation to the lower end of the trachea, as follows:

1. the 1st curve runs upwards and to the left with its convexity upwards in front of the lower end of the trachea.
2. the 2nd curve runs backwards on the left side of the lower end of the trachea (its convexity is directed forwards and to the left).

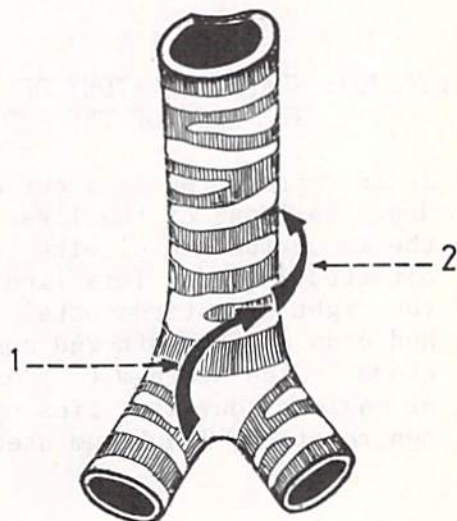


Fig.(378): DIRECTION OF THE ARCH OF THE AORTA

The arch of the aorta lies at 1st in front of the lower end of the trachea and then comes on its left side as well as on the left side of of the oesophagus and the 4th T.V.

1. thoracic duct (behind the left edge of the oesophagus).
2. oesophagus (to the right of the arch of the aorta).
3. left recurrent laryngeal nerve (in the left groove between the trachea and oesophagus).
4. lower end of trachea (behind and to the right of the arch of the aorta).
5. beginning of the arch of the aorta.
6. arch of the aorta in front of the trachea.
7. arch of the aorta on the left side of the trachea and oesophagus.
8. end of the arch of the aorta on the left side of the body of the 4th T.V.

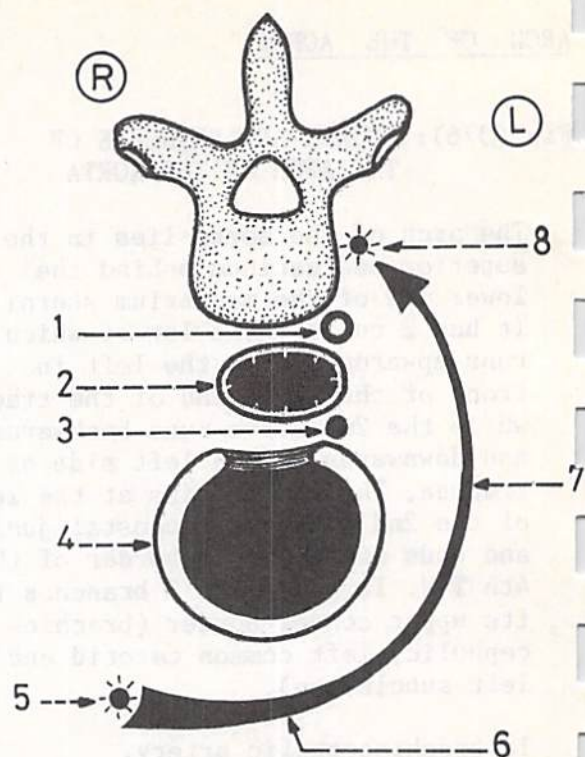


Fig.(379): SURFACE ANATOMY OF THE ARCH OF THE AORTA

It is represented by a curved line drawn in front of the lower 1/2 of the manubrium sterni with its convexity directed upwards. This line begins at the right 2nd sternocostal junction (1), and ends at the left 2nd costal cartilage close to the sternum (3), and the point of maximum convexity lies opposite the centre of the manubrium sterni (2).

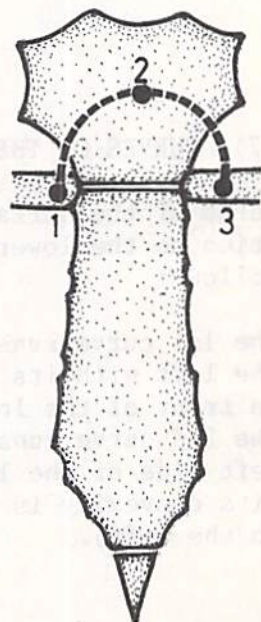
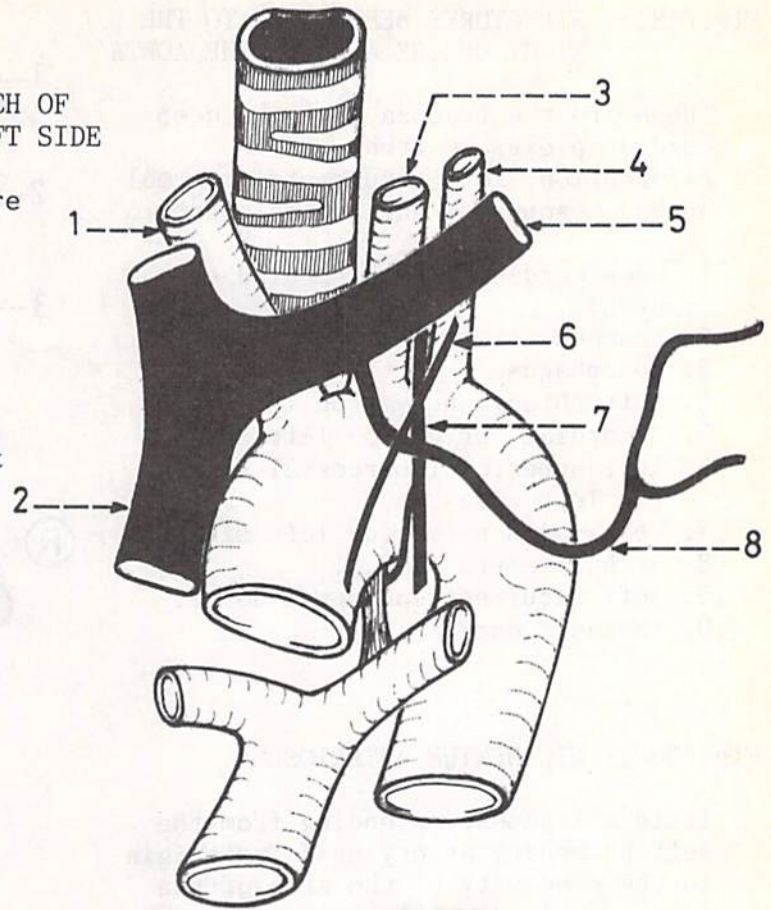


Fig.(380): STRUCTURES ABOVE THE ARCH OF THE AORTA AND ON ITS LEFT SIDE

The structures above the arch are the origins of the 3 branches of the arch in addition to the left brachiocephalic vein. The structures on the left side and in front of the arch are the left vagus, left phrenic and 2 cervical cardiac nerves, in addition to the superior left intercostal vein.

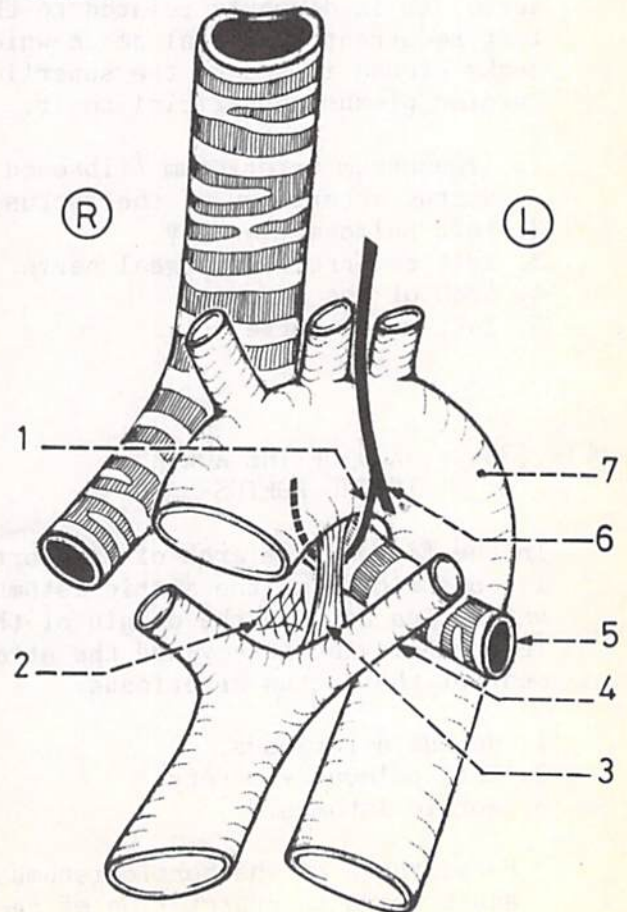


1. brachiocephalic artery.
2. superior vena cava.
3. left common carotid artery.
4. left subclavian artery.
5. left brachiocephalic (innominate) vein.
6. left phrenic nerve.
7. left vagus nerve.
8. left superior intercostal vein.

* The 2 cardiac nerves (lower cervical cardiac branch of left vagus and upper cervical cardiac branch of left sympathetic trunk) are not shown in the figure.

Fig.(381): STRUCTURES BELOW THE ARCH OF THE AORTA

These are the bifurcation of pulmonary trunk, left principal bronchus, ligamentum arteriosum, left recurrent laryngeal nerve and superficial cardiac plexus.



1. left recurrent laryngeal nerve.
2. superficial cardiac plexus.
3. ligamentum arteriosum (extends from the left pulmonary artery to the arch of aorta).
4. left pulmonary artery.
5. left principal bronchus.
6. left vagus nerve.
7. arch of the aorta.

Fig.(382): STRUCTURES BEHIND AND TO THE RIGHT OF THE ARCH OF THE AORTA

These are the trachea with the deep cardiac plexus in front of its bifurcation, left recurrent laryngeal nerve, oesophagus and thoracic duct.

1. deep cardiac plexus (behind the arch).
2. trachea.
3. oesophagus.
4. left phrenic nerve (on left side).
5. 2 cardiac nerves (on left side).
6. left superior intercostal vein (on left side).
7. left vagus nerve (on left side).
8. arch of aorta (T.S.).
9. left recurrent laryngeal nerve.
10. thoracic duct.

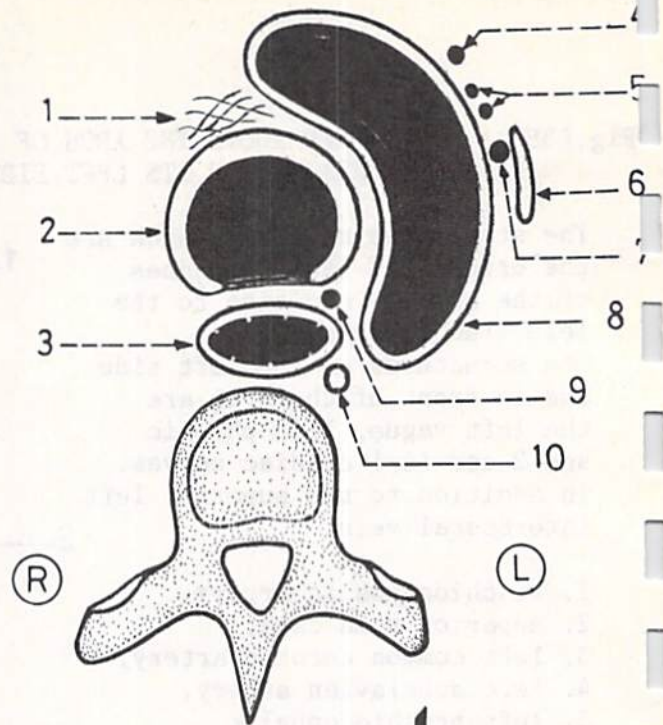


Fig.(383): LIGAMENTUM ARTERIOSUM

It is a ligament extending from the left pulmonary artery near its origin to the concavity of the arch of the aorta. It is directly related to the left recurrent laryngeal nerve which hooks around it and to the superficial cardiac plexus superficial to it.

1. ligamentum arteriosum (fibrosed ductus arteriosus of the foetus).
2. left pulmonary artery.
3. left recurrent laryngeal nerve.
4. arch of the aorta.
5. left vagus nerve.

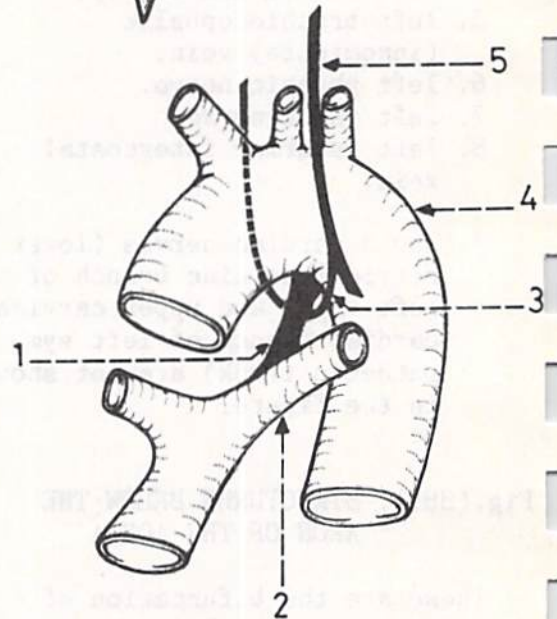
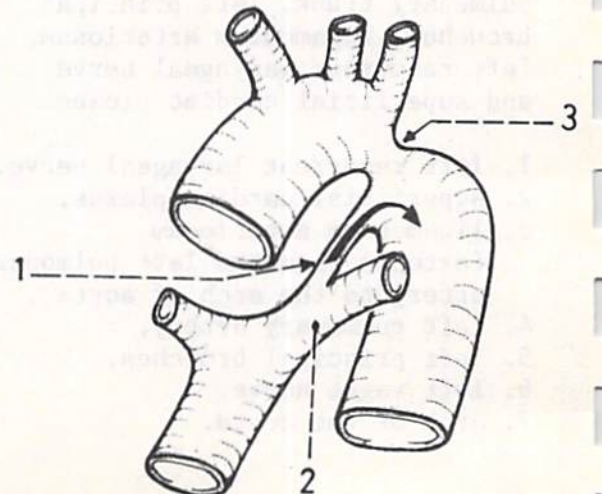


Fig.(384): ARCH OF THE AORTA IN THE FOETUS

In the foetus, the arch of the aorta is constricted at the aortic isthmus which lies between the origin of the left subclavian artery and the attachment of the ductus arteriosus.

1. ductus arteriosus.
2. left pulmonary artery.
3. aortic isthmus.

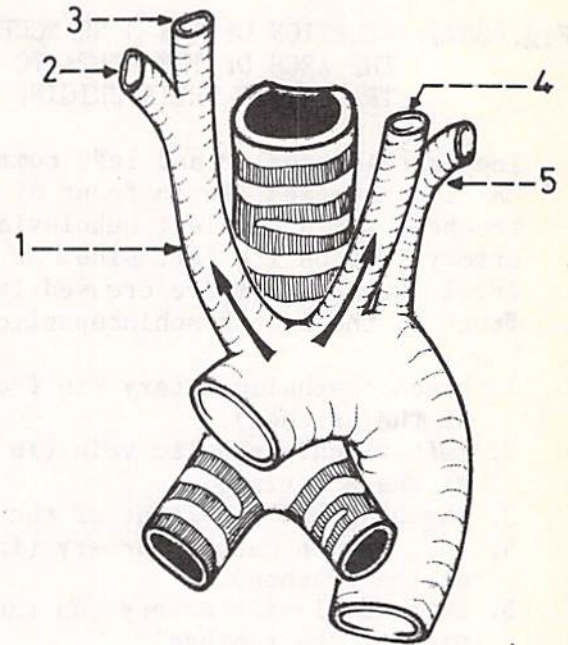


* Persistence of the aortic isthmus in the adult leads to coarctation of the aorta.

BRANCHES OF THE ARCH OF THE AORTA

Fig.(385): ORIGIN AND COURSE OF THE 3 BRANCHES OF THE ARCH OF THE AORTA

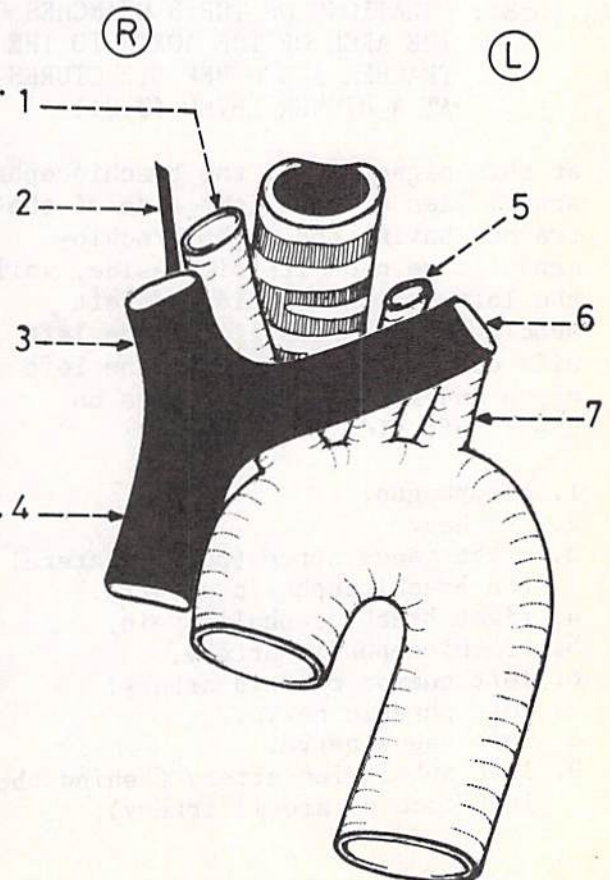
The arch of the aorta gives off the brachiocephalic, left common carotid and left subclavian arteries (from right to left). These 3 branches run upwards in direct contact with the trachea: the brachiocephalic artery ascends on its right side, while the left common carotid and left subclavian arteries ascend on its left side.



1. brachiocephalic (innominate) artery: begins in front of the trachea and ends behind the right sternoclavicular joint by dividing into right subclavian and right common carotid arteries.
2. right subclavian artery.
3. right common carotid artery.
4. left common carotid artery: arises in front of the trachea and enters the neck behind the left sternoclavicular joint.
5. left subclavian artery: arises on the left side of the trachea and ascends behind the left common carotid artery.

Fig.(386): RELATIONS OF THE 3 BRANCHES OF THE ARCH OF AORTA TO THE BRACHIOCEPHALIC VEINS

The left brachiocephalic vein crosses obliquely from left to right in front of the 3 branches of the arch of the aorta close to their origins. The right brachiocephalic vein descends on the right side of the brachiocephalic artery.



1. brachiocephalic artery.
2. right vagus nerve (posterolateral to the brachiocephalic artery).
3. right brachiocephalic vein.
4. superior vena cava.
5. left common carotid artery.
6. left brachiocephalic vein.
7. left subclavian artery.

Fig.(387): RELATION OF THE 3 BRANCHES OF THE ARCH OF THE AORTA TO THE TRACHEA AT THEIR ORIGINS (T.S.)

The brachiocephalic and left common carotid arteries lie in front of the trachea, while the left subclavian artery lies on its left side. At this level the arteries are crossed in front by the left brachiocephalic vein.

1. brachiocephalic artery (in front of the trachea).
2. left brachiocephalic vein (in front of the arteries).
3. thymus gland (in front of the vein).
4. left common carotid artery (in front of the trachea).
5. left subclavian artery (on the left side of the trachea).
6. trachea.
7. oesophagus.

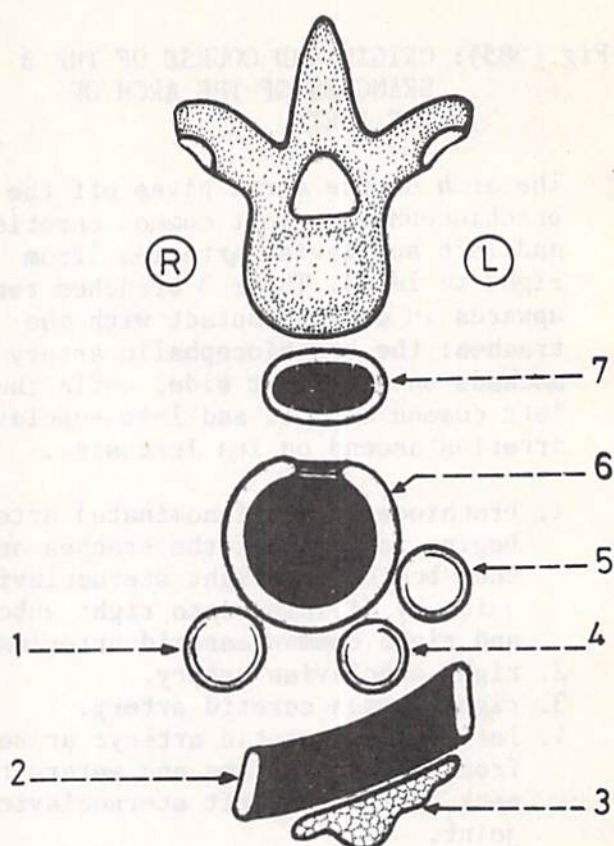
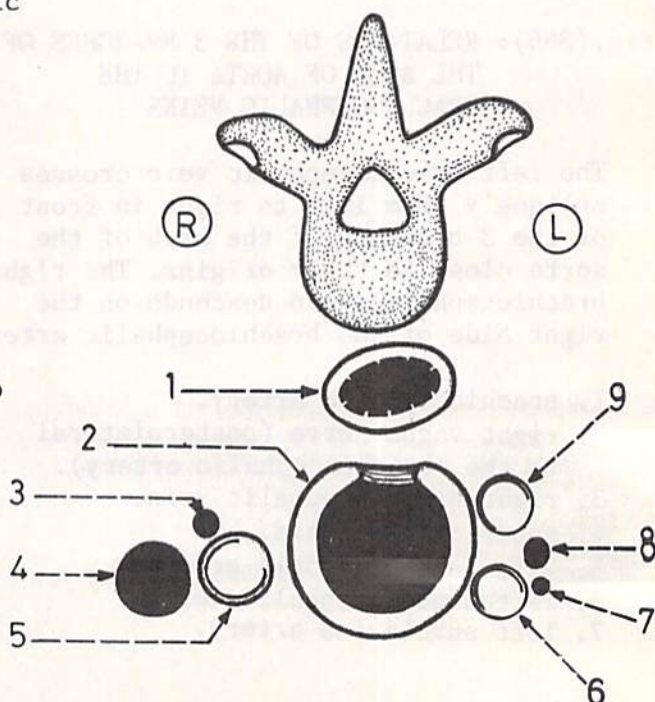


Fig.(388): RELATIONS OF THE 3 BRANCHES OF THE ARCH OF THE AORTA TO THE TRACHEA AND OTHER STRUCTURES AT A HIGHER LEVEL (T.S.)

At this higher level the brachiocephalic artery lies on the right side of the trachea having the right brachiocephalic vein on its right side, while the left common carotid and left subclavian arteries lie on the left side of the trachea having the left vagus and left phrenic nerves on their left side.

1. oesophagus.
2. trachea.
3. right vagus nerve (posterolateral to the brachiocephalic artery).
4. right brachiocephalic vein.
5. brachiocephalic artery.
6. left common carotid artery.
7. left phrenic nerve.
8. left vagus nerve.
9. left subclavian artery (behind the left common carotid artery).



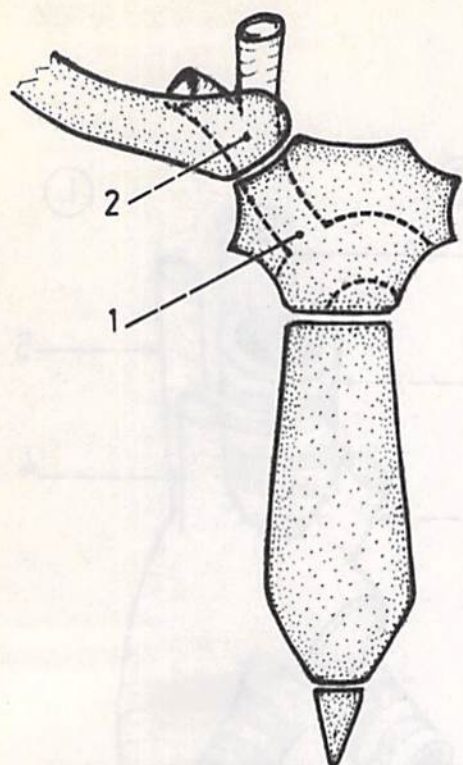


Fig.(389): COURSE OF BRACHIOCEPHALIC ARTERY

It arises near the centre of the manubrium sterni (1), and ascends upwards, backwards and to the right to end opposite the right sternoclavicular joint (2).

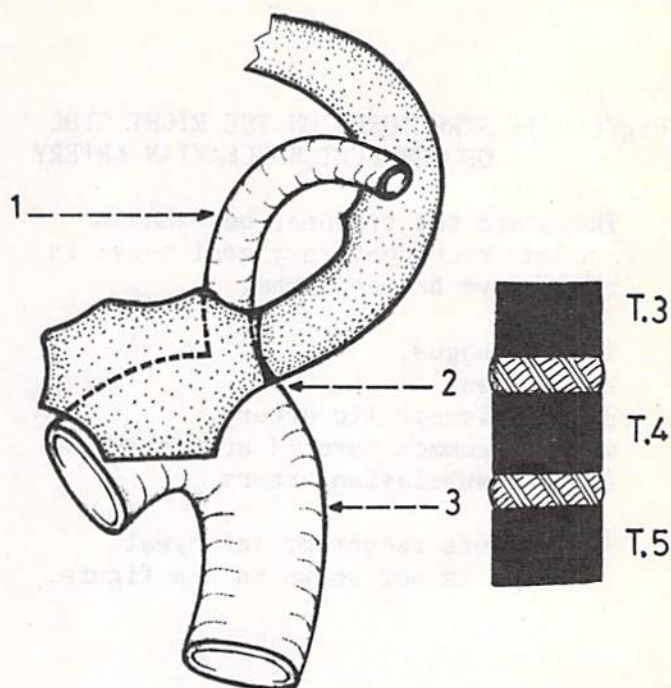


Fig.(390): COURSE OF LEFT SUBCLAVIAN ARTERY

It arises opposite the lower border of the 3rd T.V. and enters the root of the neck behind the left sternoclavicular joint.

1. left subclavian artery.
2. origin of left subclavian artery.
3. end of the arch of aorta.

Fig(391): COURSE OF LEFT COMMON CAROTID ARTERY

It arises near the centre of the manubrium sterni and ascends in front of the left subclavian artery to enter the root of the neck behind the left sternoclavicular joint.

1. left common carotid artery.
2. left subclavian artery.
3. brachiocephalic artery.

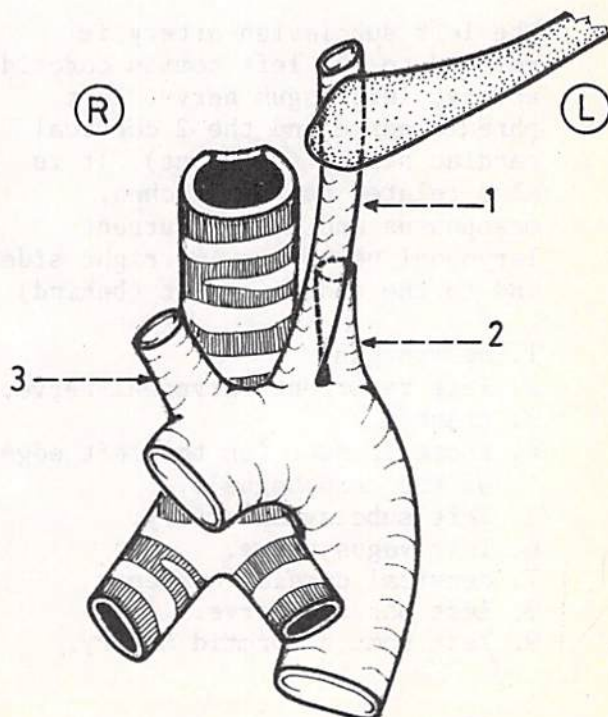


Fig.(392): STRUCTURES ON THE RIGHT SIDE OF THE LEFT SUBCLAVIAN ARTERY

These are the trachea, oesophagus and left recurrent laryngeal nerve in the groove between them.

1. oesophagus.
2. trachea.
3. brachiocephalic artery.
4. left common carotid artery.
5. left subclavian artery.

* The left recurrent laryngeal nerve is not shown in the figure.

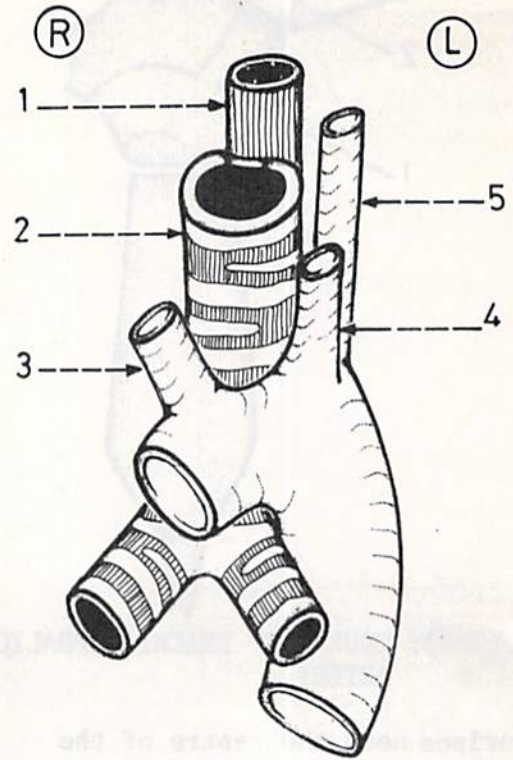
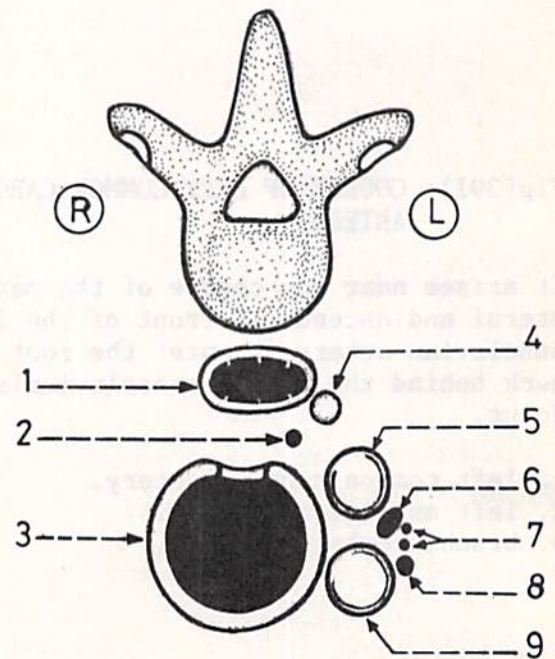


Fig.(393): RELATIONS OF THE LEFT SUBCLAVIAN ARTERY (T.S.)

The left subclavian artery is related to the left common carotid artery, left vagus nerve, left phrenic nerve and the 2 cervical cardiac nerves (in front). It is also related to the trachea, oesophagus and left recurrent laryngeal nerve (on its right side), and to the thoracic duct (behind).

1. oesophagus.
2. left recurrent laryngeal nerve.
3. trachea.
4. thoracic duct (on the left edge of the oesophagus).
5. left subclavian artery.
6. left vagus nerve.
7. cervical cardiac nerves.
8. left phrenic nerve.
9. left common carotid artery.



DESCENDING AORTA

Fig.(394): COURSE OF THE DESCENDING AORTA

The descending aorta begins at the lower border of the 4th T.V. as the continuation of the arch of the aorta. It descends obliquely in the posterior mediastinum to end on the front of the lower border of the 12th T.V. to become the abdominal aorta.

1. beginning of the descending aorta (opposite the lower border of the 4th T.V.).
2. end of the descending aorta (opposite the lower border of the 12th T.V.).

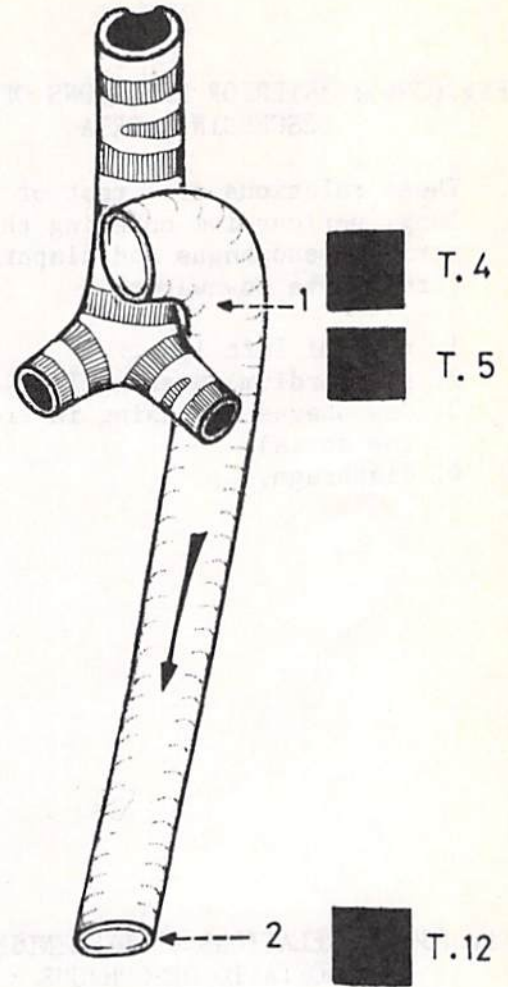


Fig.(395): SURFACE ANATOMY OF DESCENDING AORTA

It is represented by a vertical line extending from the 2nd left sternocostal junction (1) to a point in the midline of the anterior abdominal wall midway between the umbilicus and the xiphoid process (2).

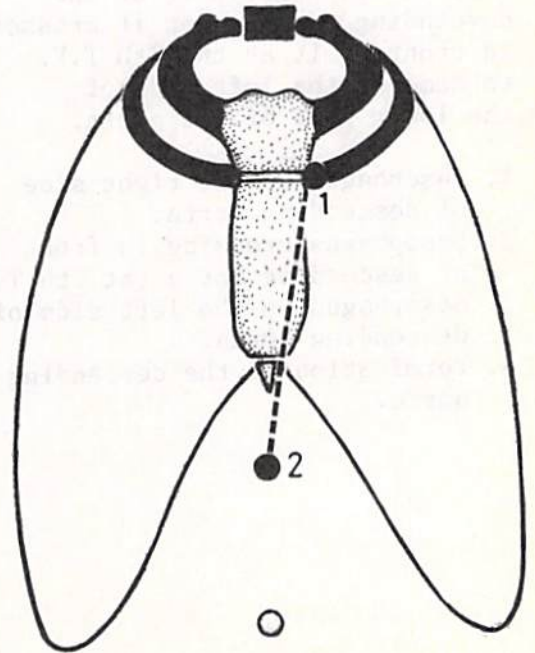


Fig.(396): ANTERIOR RELATIONS OF
DESCENDING AORTA

These relations are: root of left lung, pericardium covering the left atrium, oesophagus and diaphragm (from above downwards).

1. root of left lung.
2. pericardium covering left atrium.
3. oesophagus (crossing in front of the aorta).
4. diaphragm.

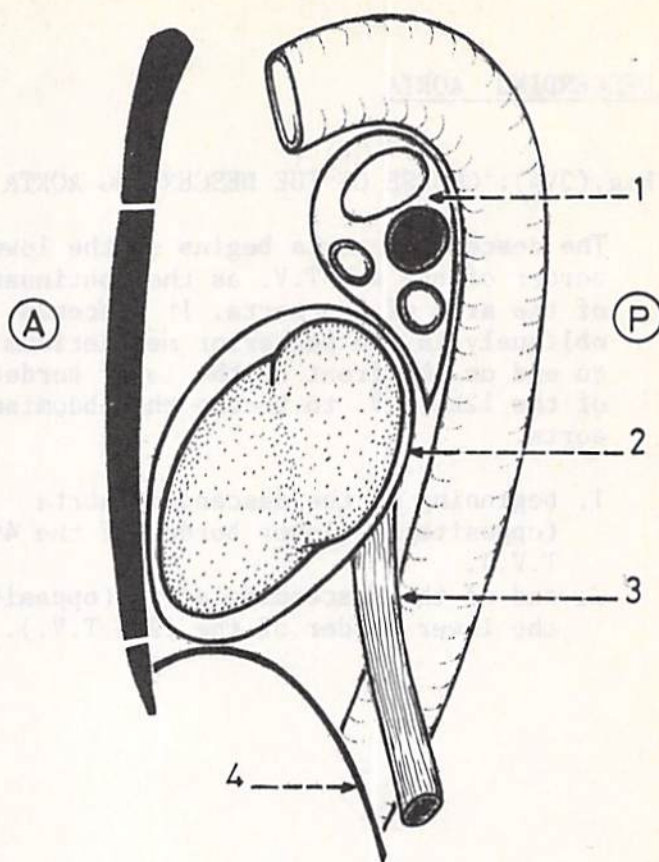


Fig.(397): RELATIONS OF DESCENDING
AORTA TO OESOPHAGUS

The oesophagus lies on the right side of the upper part of the descending aorta, then it crosses in front of it at the 7th T.V. to come on the left side of the lower part of the aorta.

1. oesophagus on the right side of descending aorta.
2. oesophagus crossing in front of descending aorta (at 7th T.V.).
3. oesophagus on the left side of descending aorta.
4. termination of the descending aorta.

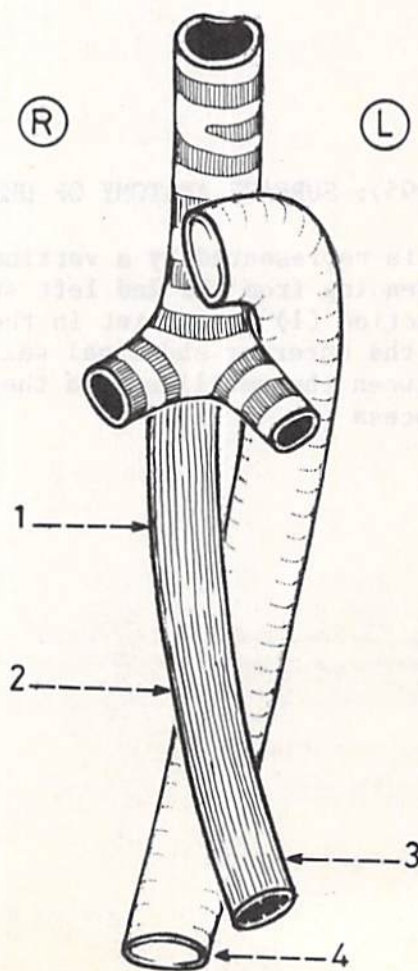


Fig.(398): STRUCTURES ON THE RIGHT SIDE OF DESCENDING AORTA

These are the oesophagus, thoracic duct and azygos vein.

1. oesophagus on the right side of the upper part of descending aorta.
2. azygos vein.
3. thoracic duct.
4. descending aorta.

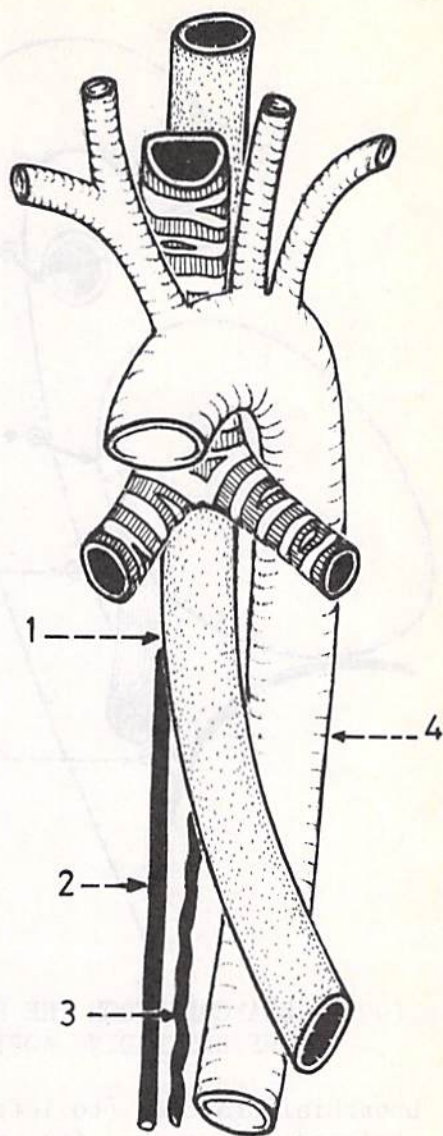
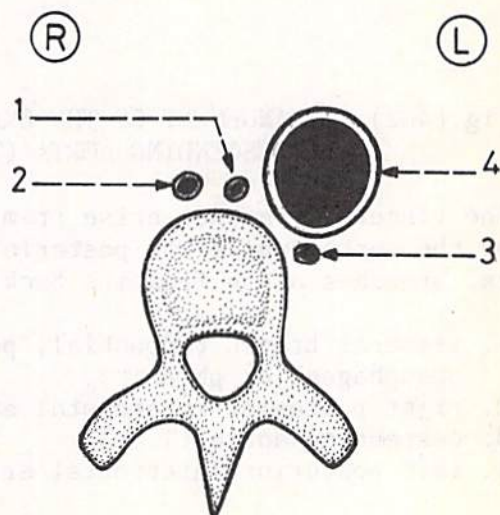


Fig.(399): STRUCTURES BEHIND AND TO THE RIGHT OF DESCENDING AORTA (T.S.)

The vertebral column and hemiazygos veins lie behind the descending aorta.

1. thoracic duct (on the right side)
2. azygos vein (on the right side).
3. hemiazygos vein (behind).
4. descending aorta.



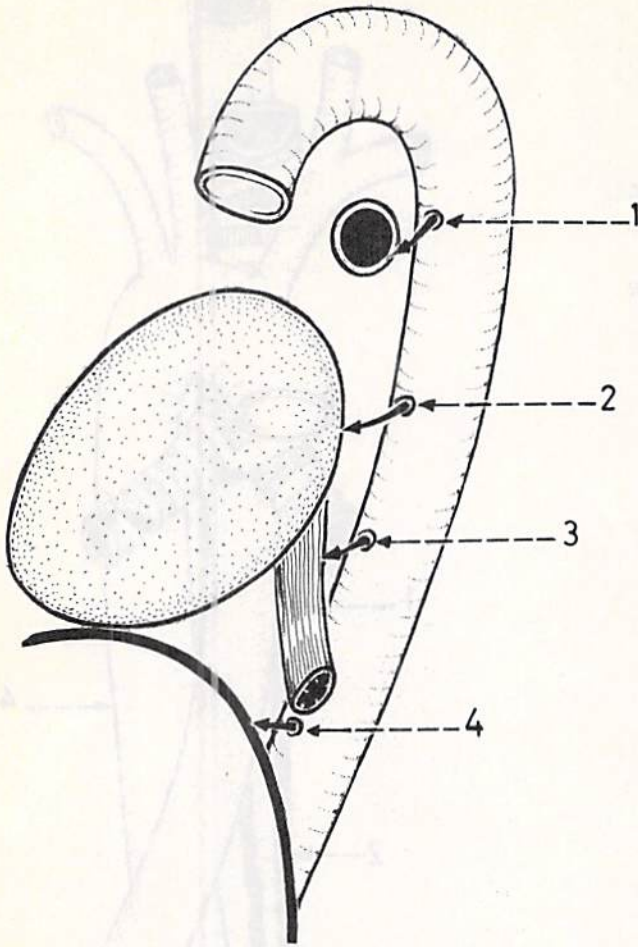


Fig.(400): BRANCHES FROM THE FRONT OF THE DESCENDING AORTA

1. bronchial branches (to left bronchus).
2. pericardial branches (to pericardium).
3. oesophageal branches (to oesophagus).
4. phrenic branches (to diaphragm).

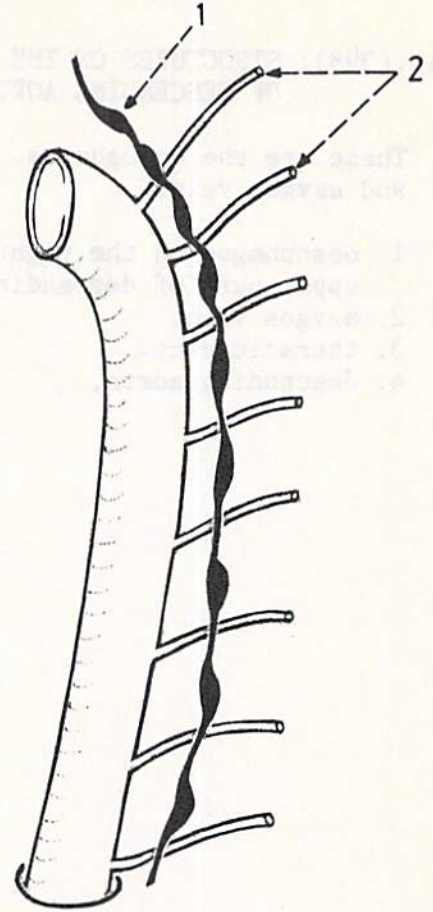


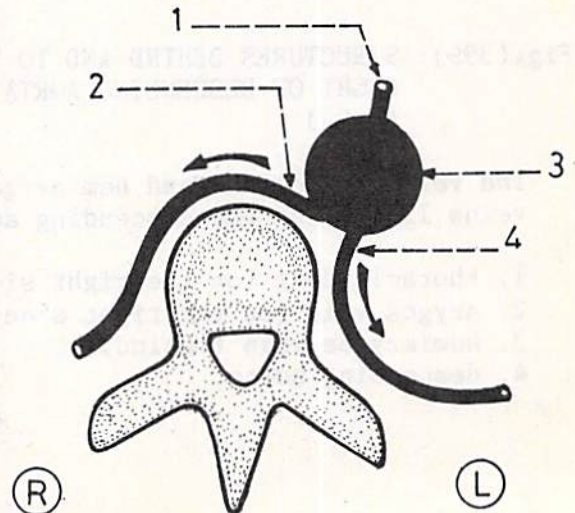
Fig.(401): BRANCHES FROM THE BACK OF THE DESCENDING AORTA

- These are the lower 9 intercostal and subcostal arteries of both sides.
1. sympathetic trunk (descends in front of the intercostal arteries).
 2. left intercostal arteries.

Fig.(402): ARRANGEMENT OF THE BRANCHES OF DESCENDING AORTA (T.S.)

The visceral branches arise from the front of the aorta, while the posterior intercostal branches arise from its back.

1. visceral branch (bronchial, pericardial, oesophageal or phrenic).
2. right posterior intercostal artery.
3. descending aorta (T.S.).
4. left posterior intercostal artery.

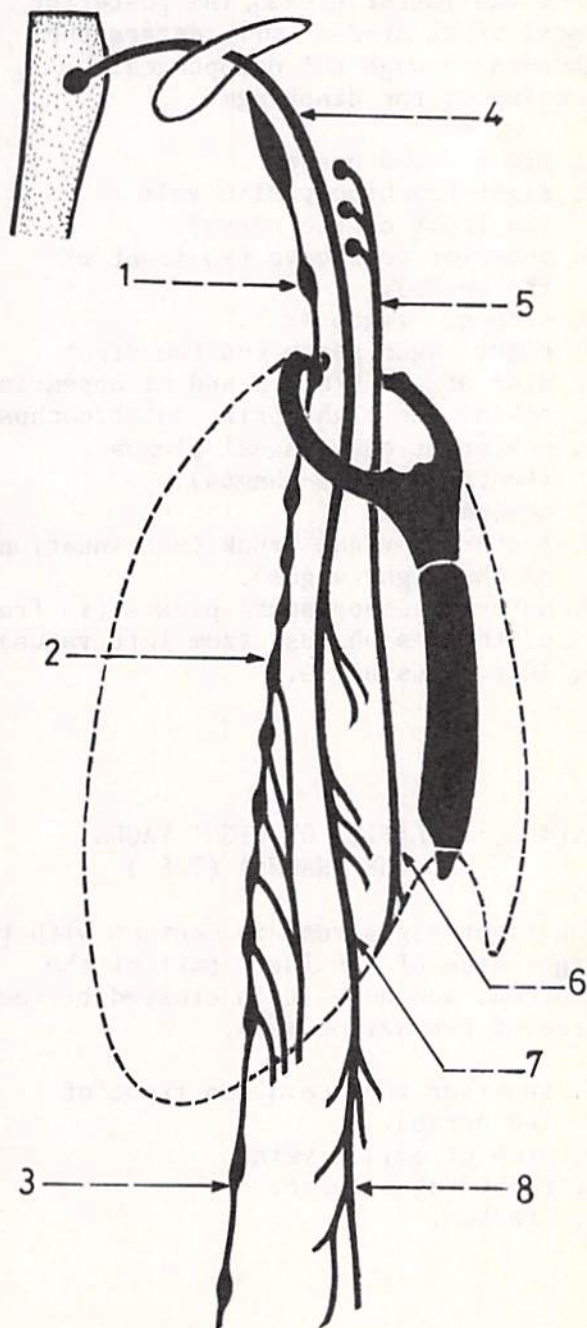


NERVES IN THE CHEST CAVITY

Fig.(403): NERVES IN THE CHEST CAVITY

These are the vagus nerve, phrenic nerve and sympathetic trunk on both sides. They run vertically through the chest cavity from the thoracic inlet to the thoracic outlet. This is in contrast to the intercostal nerves which run horizontally in the chest wall.

1. cervical part of sympathetic trunk (in the neck).
2. thoracic part of sympathetic trunk (in the chest cavity in close contact with the heads of the ribs).
3. abdominal part of sympathetic trunk (in the abdomen).
4. vagus nerve in the neck.
5. phrenic nerve in the neck.
6. phrenic nerve in the chest cavity (on the side of the pericardium).
7. vagus nerve in the chest.
8. vagus nerve in the abdomen.



VAGUS NERVE

Fig.(404): COURSE OF RIGHT VAGUS NERVE

It descends on the right side of the trachea behind the right brachiocephalic vein and superior vena cava. It continues downwards behind the root of the right lung where it forms the posterior pulmonary plexus, and then behind the oesophagus to form the posterior oesophageal plexus. From the latter plexus, the posterior vagal trunk arises and enters the abdomen through the oesophageal opening of the diaphragm.

1. right vagus nerve.
2. right brachiocephalic vein (in front of the nerve).
3. superior vena cava (in front of the nerve).
4. arch of azygos vein.
5. right vagus nerve (on the right side of the trachea and disappearing behind the right principal bronchus).
6. posterior oesophageal plexus (behind the oesophagus).
7. oesophagus.
8. posterior vagal trunk (continuation of the right vagus).
9. anterior oesophageal plexus (in front of the oesophagus; from left vagus).
10. left vagus nerve.

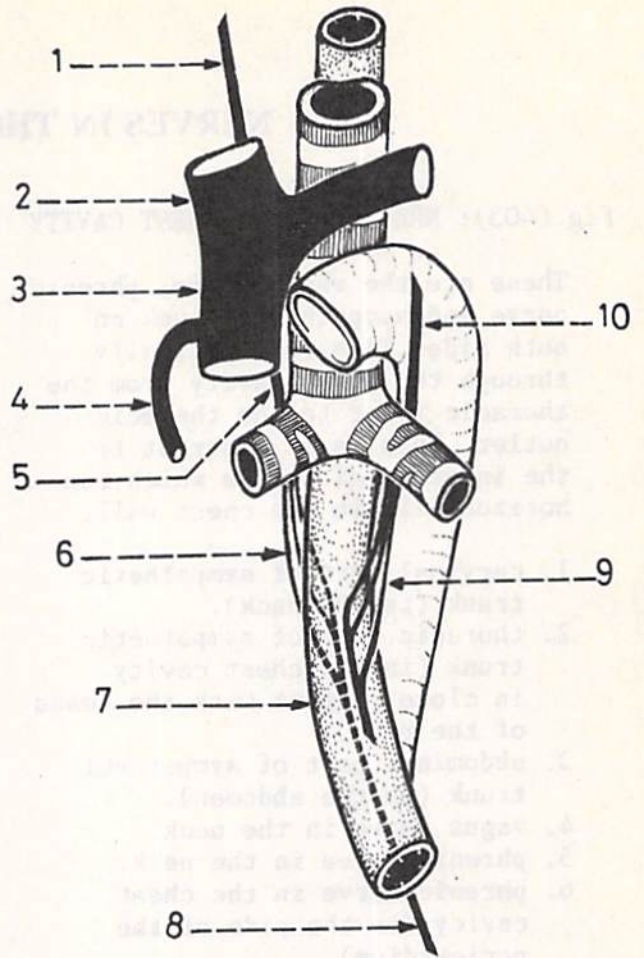


Fig.(405): RELATION OF RIGHT VAGUS TO THE TRACHEA (T.S.)

The right vagus runs in contact with the right side of the lower part of the trachea, and here it is crossed by the arch of the azygos vein.

1. superior vena cava (in front of the nerve).
2. arch of azygos vein.
3. right vagus nerve.
4. trachea.

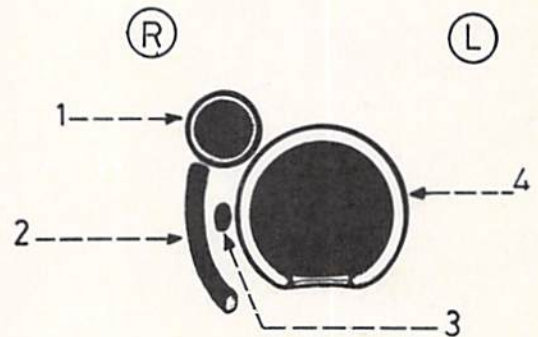


Fig.(406): COURSE OF LEFT VAGUS NERVE

It descends between the left common carotid and left subclavian arteries and crosses the left side of the aortic arch to pass behind the root of the left lung. It forms the posterior pulmonary plexus and continues in front of the oesophagus to form the anterior oesophageal plexus. From the latter plexus, the anterior vagal trunk arises and enters the abdomen through the oesophageal opening of the diaphragm.

1. right vagus nerve.
2. posterior oesophageal plexus.
3. oesophagus.
4. posterior vagal trunk.
5. left vagus nerve (descends between the left common carotid and left subclavian arteries).
6. left vagus nerve (crosses on the left side of the aortic arch and disappears behind the left principal bronchus).
7. anterior oesophageal plexus.
8. anterior vagal trunk.

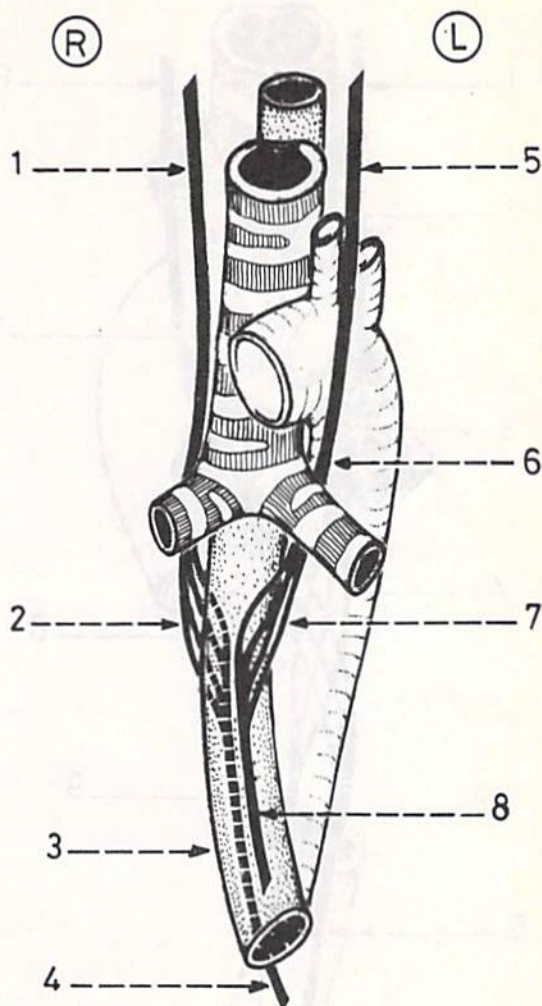
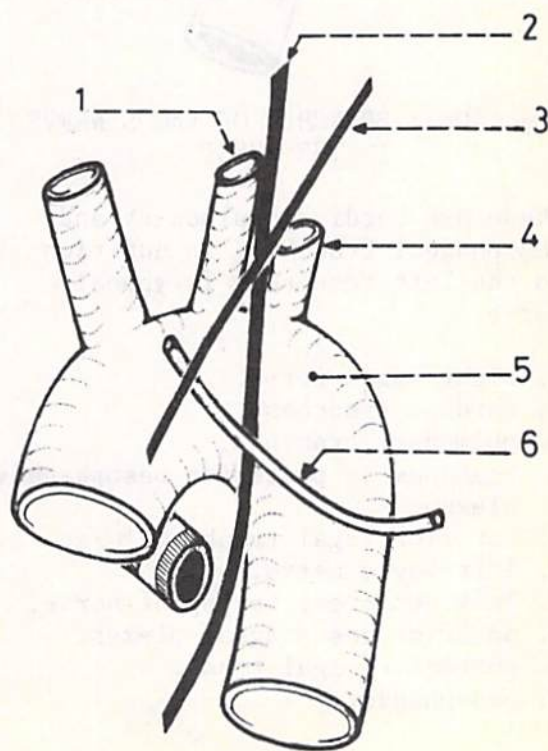


Fig.(407): RELATIONS OF LEFT VAGUS NERVE AS IT CROSSES THE AORTIC ARCH

On the left side of the aortic arch, the vagus nerve is crossed by the left superior intercostal vein, while just above the aortic arch the vagus nerve is crossed by the left phrenic nerve.

1. left common carotid artery.
2. left vagus nerve (between the left common carotid and left subclavian arteries).
3. left phrenic nerve crossing over the left vagus nerve just above the aortic arch.
4. left subclavian artery.
5. arch of the aorta.
6. left superior intercostal vein (crossing over the vagus nerve on the arch of the aorta).



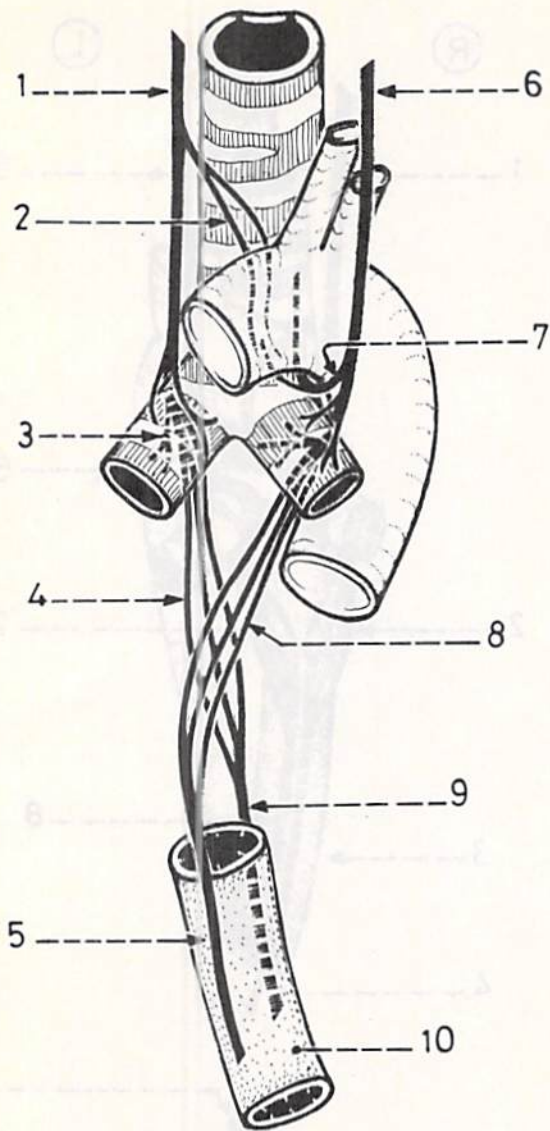


Fig.(408): BRANCHES OF VAGUS NERVE IN THE CHEST

These are cardiac, pulmonary and oesophageal branches, in addition to the left recurrent laryngeal nerve.

1. right vagus nerve.
2. cardiac branches.
3. pulmonary branches.
4. branches to posterior oesophageal plexus.
5. anterior vagal trunk.
6. left vagus nerve.
7. left recurrent laryngeal nerve.
8. anterior oesophageal plexus.
9. posterior vagal trunk.
10. oesophagus.

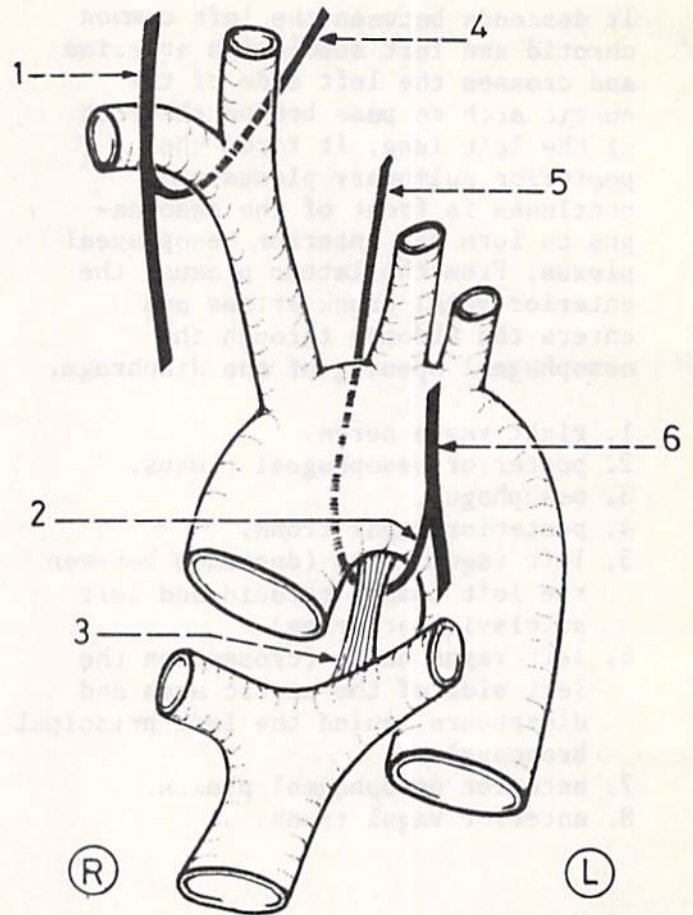


Fig.(409): RIGHT AND LEFT RECURRENT LARYNGEAL NERVES

The right recurrent laryngeal nerve arises in the neck and curves round the right subclavian artery, while the left recurrent laryngeal nerve arises in the superior mediastinum and winds below the aortic arch and then ascends behind it.

1. right vagus nerve in the neck.
2. left recurrent laryngeal nerve.
3. ligamentum arteriosum.
4. right recurrent laryngeal nerve (winding round the right subclavian artery).
5. left recurrent laryngeal nerve ascending in the superior mediastinum.
6. left vagus nerve (gives off the left recurrent laryngeal nerve).

PHRENIC NERVE

Fig.(410): COURSE OF RIGHT PHRENIC NERVE

The phrenic nerve arises in the neck from the 3rd, 4th and 5th cervical nerves. It has a part in the neck and a part in the chest. In the chest it descends on the right side of the right brachiocephalic vein, superior vena cava, pericardium covering the right atrium and inferior vena cava (from above downwards). It is accompanied by the pericardiophrenic vessels.

1. right phrenic nerve (in the neck).
2. right subclavian vein (in front of the nerve).
3. right brachiocephalic vein.
4. superior vena cava.
5. root of right lung behind the phrenic nerve.
6. pericardium covering the right atrium.
7. phrenic nerve.
8. diaphragm.
9. pericardiophrenic artery (from the internal thoracic artery).

* Note that the right phrenic nerve descends on venous channels.

* Note also that the right phrenic nerve is separated from the right vagus nerve by the root of the right lung.

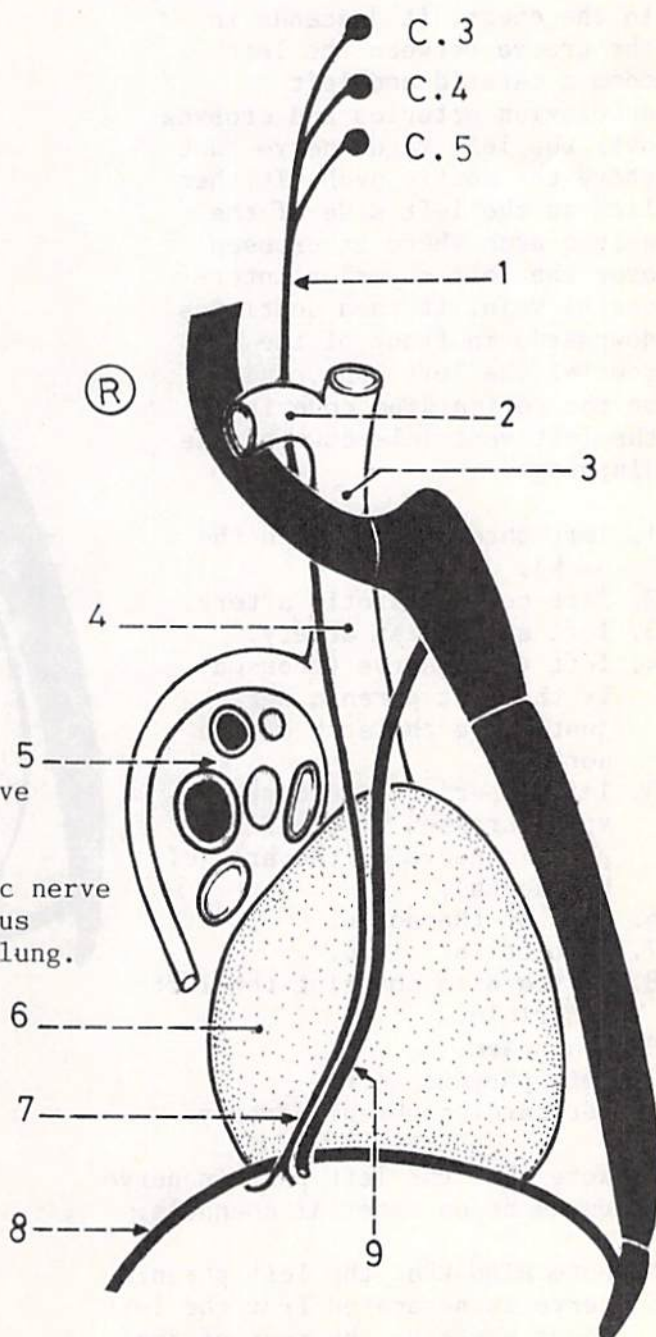


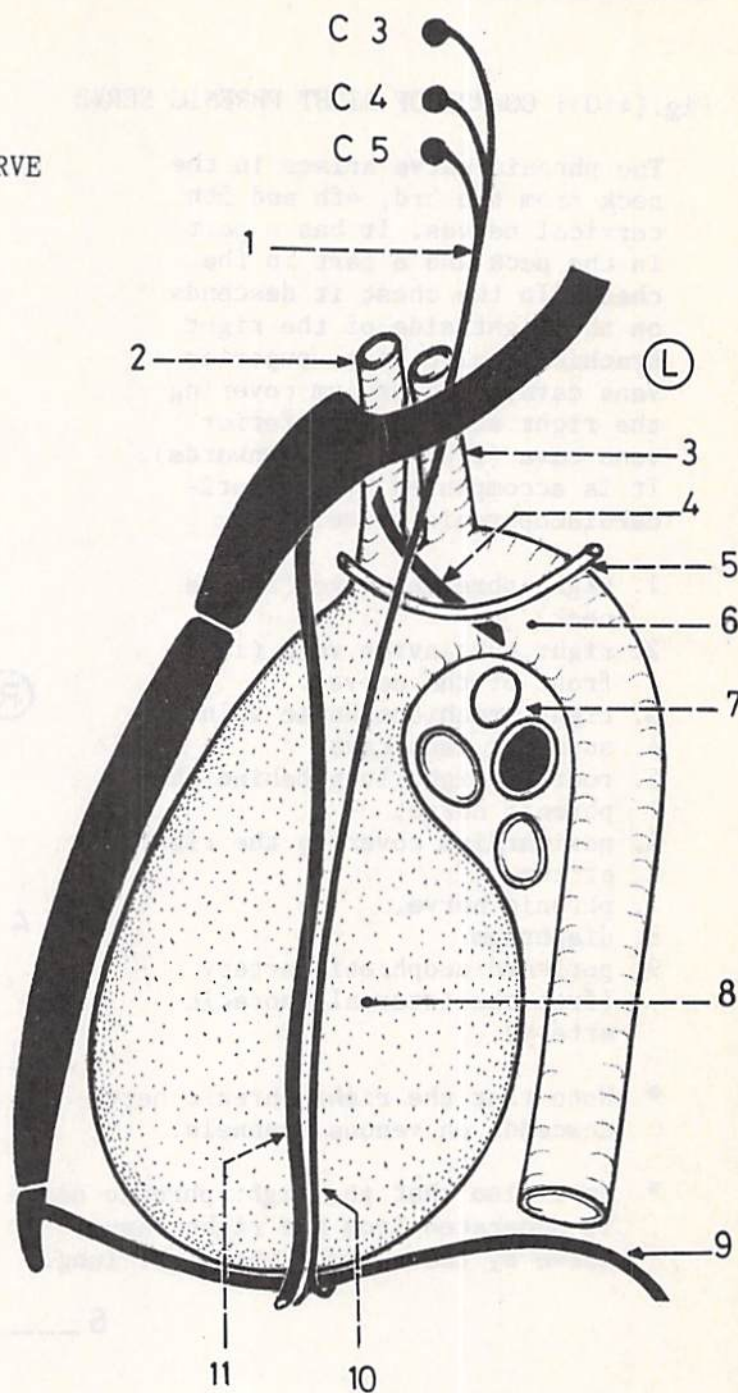
Fig.(411): COURSE OF LEFT PHRENIC NERVE

It arises in the neck (as the right phrenic nerve) from the 3rd, 4th and 5th cervical nerves. In the chest, it descends in the groove between the left common carotid and left subclavian arteries and crosses over the left vagus nerve just above the aortic arch. It then lies on the left side of the aortic arch where it crosses over the left superior intercostal vein. It then continues downwards in front of the root of the left lung, and on the pericardium covering the left ventricle down to the diaphragm.

1. left phrenic nerve (in the neck).
2. left common carotid artery.
3. left subclavian artery.
4. left vagus nerve (crossed by the left phrenic nerve just above the arch of the aorta).
5. left superior intercostal vein (crossed by the left phrenic nerve on the arch of the aorta).
6. arch of the aorta.
7. root of left lung.
8. pericardium covering the left ventricle.
9. diaphragm.
10. left phrenic nerve.
11. pericardiophrenic artery.

* Note that the left phrenic nerve descends on arterial channels.

* Note also that the left phrenic nerve is separated from the left vagus nerve by the root of the left lung.



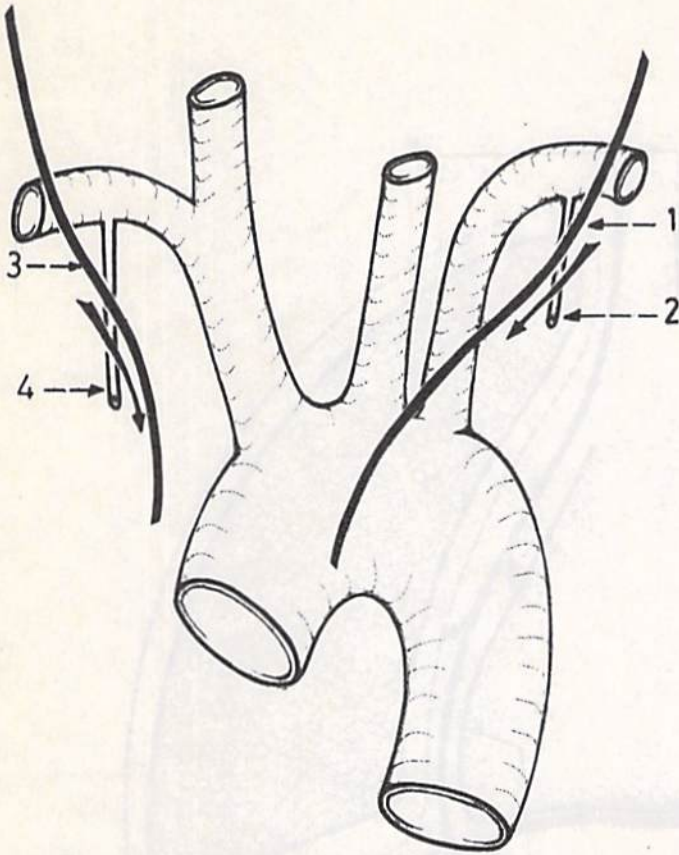


Fig.(412): RELATION OF THE PHRENIC NERVE TO THE INTERNAL THORACIC ARTERY

The phrenic nerve crosses in front of the internal thoracic artery from lateral to medial, in the root of the neck.

1. left phrenic nerve.
2. left internal thoracic artery.
3. right phrenic nerve.
4. right internal thoracic artery.

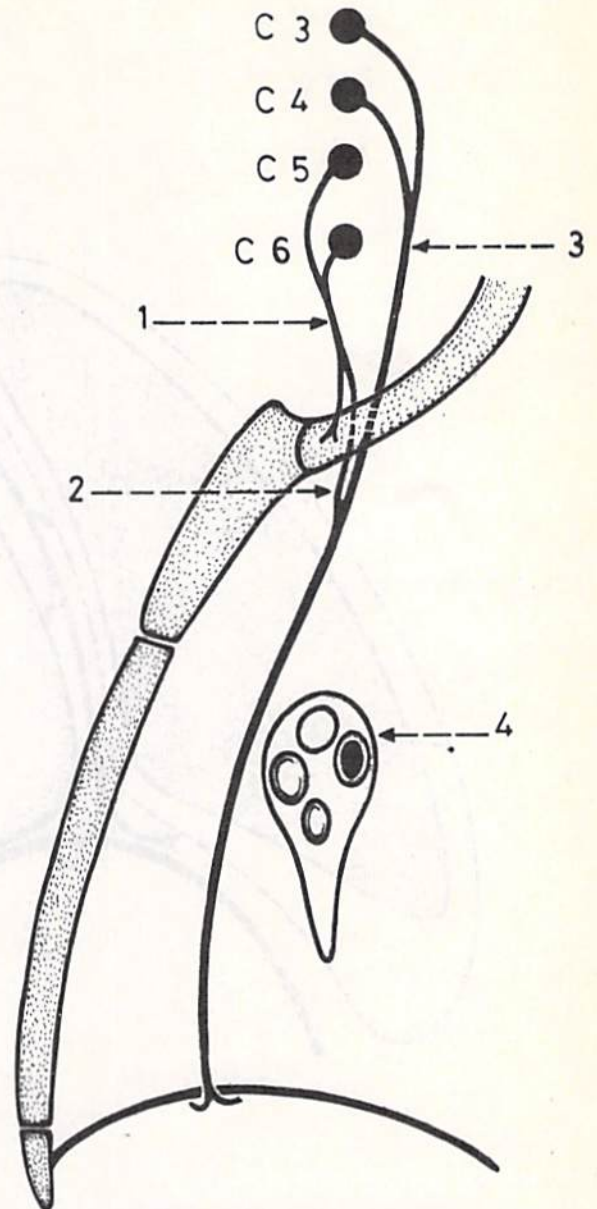


Fig.(413): ACCESSORY PHRENIC NERVE

It consists of the fibres from C.5 which arise from the nerve to subclavius. These fibres join the main phrenic nerve in the root of the neck or in the chest.

1. nerve to subclavius (C.5 & C.6).
2. accessory phrenic nerve (arises from the nerve to subclavius and joins the main phrenic nerve lower down).
3. phrenic nerve arising from C.3 and C.4 only.
4. root of the lung.

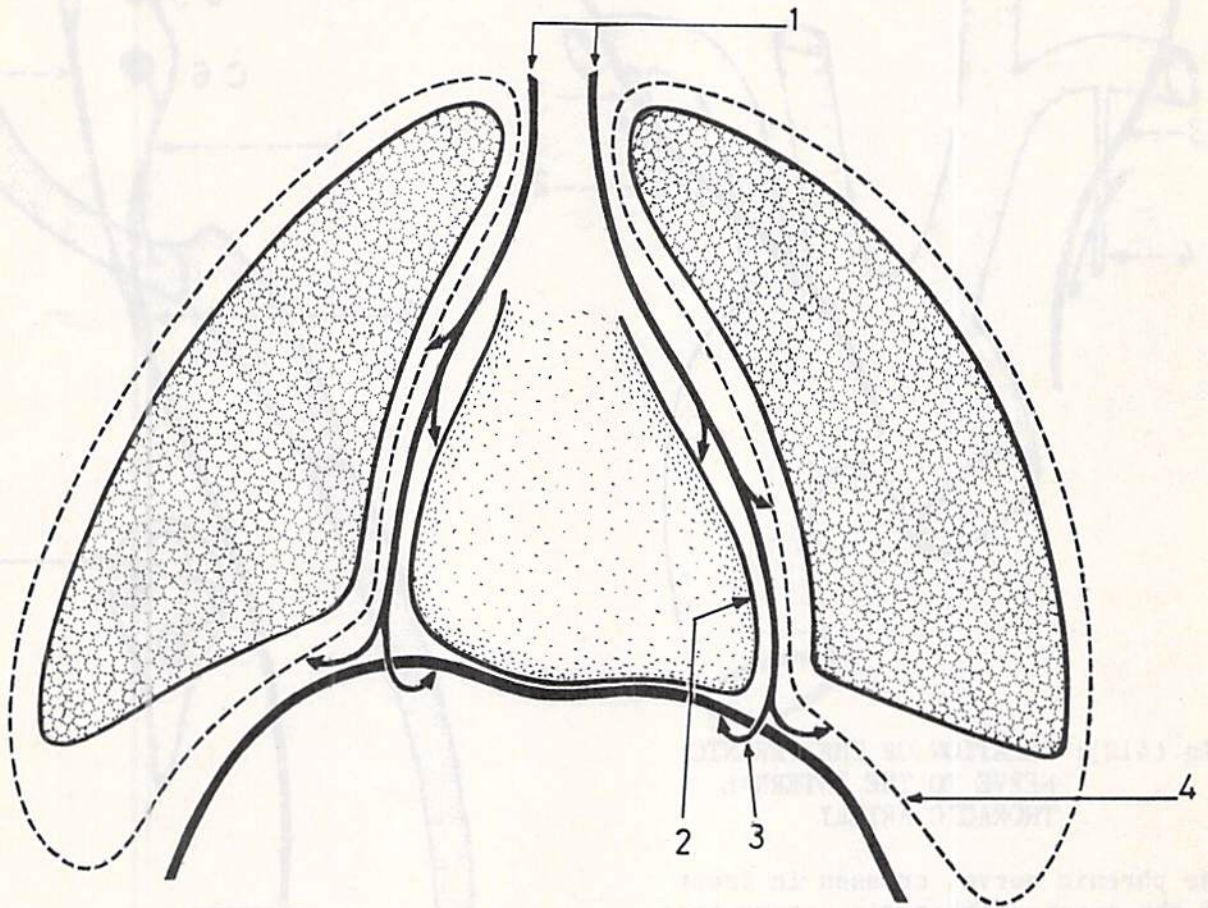


Fig.(414): DISTRIBUTION OF THE PHRENIC NERVE

The phrenic nerve contains sensory and motor fibres. The sensory fibres are distributed to the fibrous pericardium, mediastinal pleura, diaphragmatic pleura as well as the parietal peritoneum on the abdominal surface of the central tendon of the diaphragm. The motor fibres supply the muscle of the diaphragm.

1. right and left phrenic nerves.
2. fibrous pericardium.
3. fibres to the muscle of the diaphragm and the parietal peritoneum on the central tendon of the diaphragm.
4. diaphragmatic pleura.

THORACIC PART OF SYMPATHETIC TRUNK

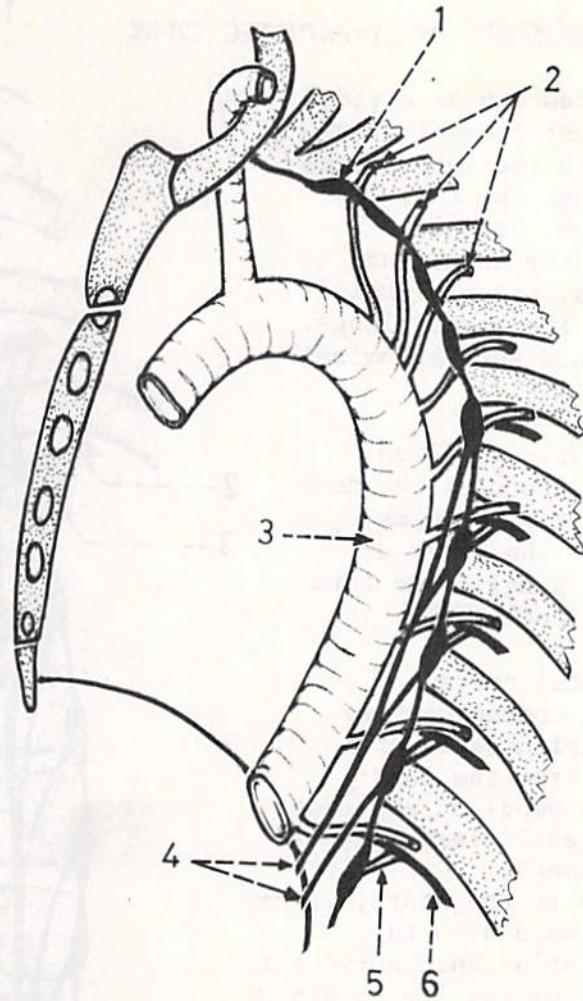


Fig.(415): COURSE OF SYMPATHETIC TRUNK

The sympathetic trunk is a chain of sympathetic nerve fibres and sympathetic ganglia which lies on the side of the vertebral column, one on each side. Each trunk runs vertically over the heads of the ribs and crosses the posterior intercostal arteries and the intercostal nerves. Each trunk has 11 ganglia each of which is connected with the corresponding spinal nerve by 2 rami communicantes.

1. left sympathetic trunk.
2. posterior intercostal arteries.
3. descending aorta.
4. splanchnic nerves.
5. rami communicantes.
6. intercostal nerve.

Fig.(416): BRANCHES OF SYMPATHETIC TRUNK

These branches can be divided into 3 groups: communicating branches with the intercostal nerves through the rami communicantes, vascular branches to the aorta and its branches, and visceral branches to the heart, lungs, oesophagus and some abdominal viscera.

1. 1st thoracic ganglion (lies in front of the neck of the 1st rib and may fuse with the inferior cervical ganglion to form the cervicothoracic ganglion).
2. intercostal nerve.
3. two rami communicantes.
4. lowest splanchnic nerve (arises from the last thoracic ganglion and ends in the renal plexus in the abdomen).
5. branches to the heart, lungs, oesophagus and aorta.
6. greater splanchnic nerve (it arises from the 5th to 9th thoracic ganglia and ends in the coeliac ganglion in the abdomen).
7. coeliac ganglion.
8. lesser splanchnic nerve (arises from the 9th and 10th thoracic ganglia and ends in the aorticorenal ganglion).
9. aorticorenal ganglion.
10. renal plexus containing ganglia.

* Note the following:

1. The three splanchnic nerves are all preganglionic.
2. The branches to the heart, lungs, oesophagus and aorta are all postganglionic.

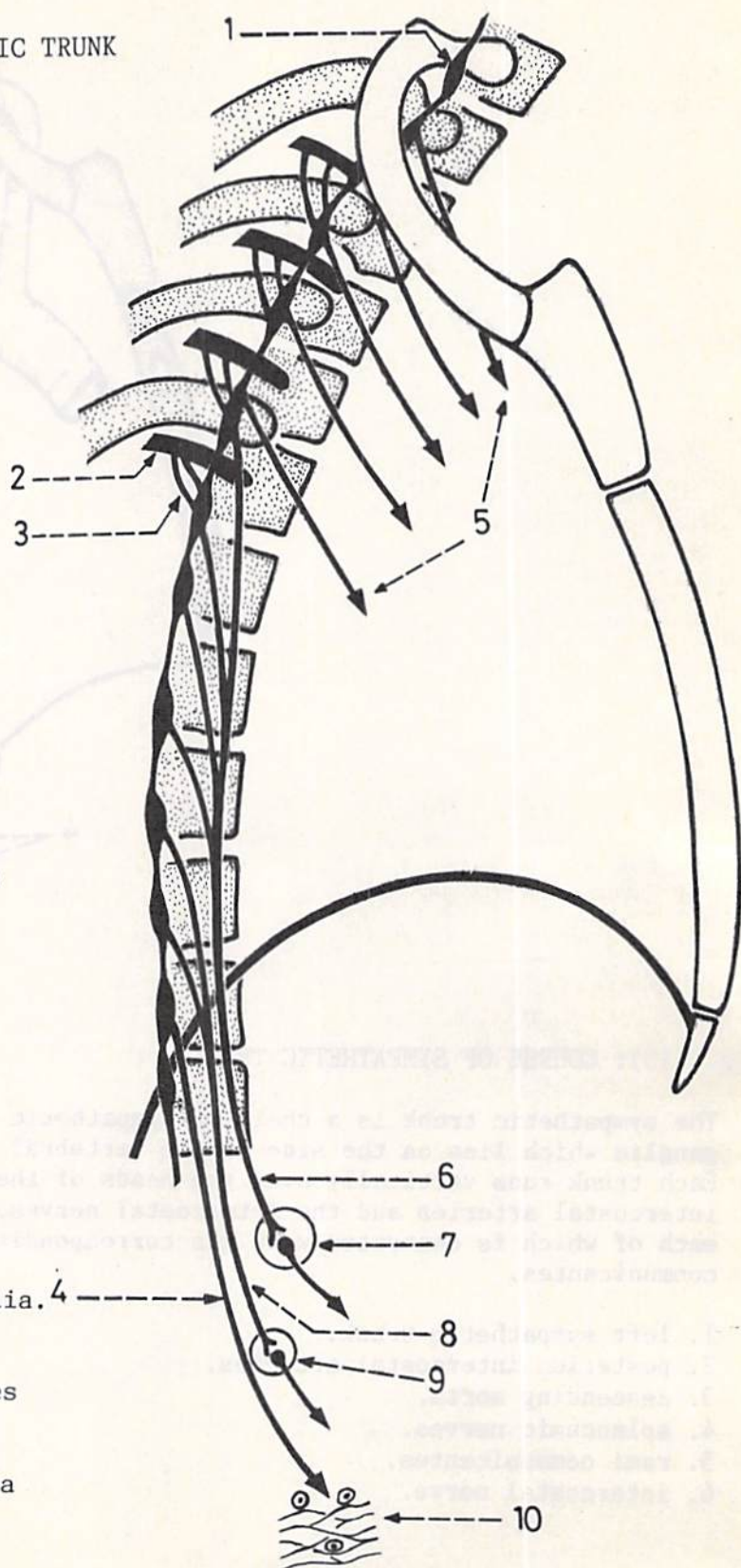


Fig.(417): POSITION OF THE SYMPATHETIC TRUNK IN THE CHEST (T.S.)

The thoracic part of the sympathetic trunk lies in front of the heads of the ribs, behind the costal pleura. The right trunk lies a short distance lateral to the azygos vein, while the left trunk lies a short distance lateral to the descending aorta and the hemiazygos veins.

1. thoracic duct.
2. azygos vein.
3. right sympathetic trunk.
4. oesophagus.
5. descending aorta.
6. hemiazygos vein.
7. left sympathetic trunk.

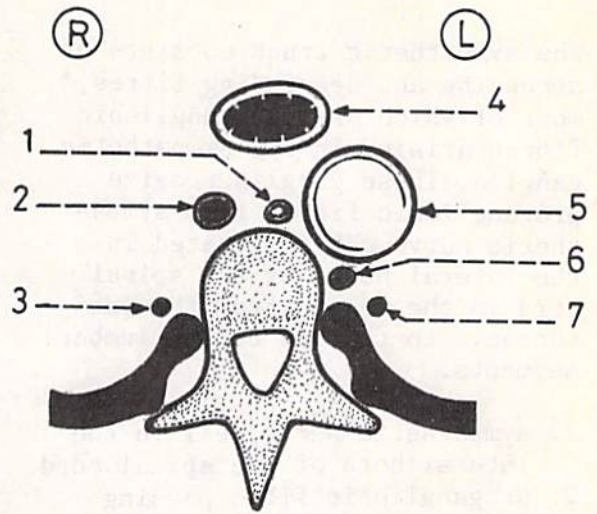


Fig.(418): AUTONOMIC PLEXUSES IN THE CHEST

These are plexuses formed by both sympathetic and parasympathetic nerves. The sympathetic fibres arise from the sympathetic trunks of both sides, while the parasympathetic nerves arise from the 2 vagus nerves and the recurrent laryngeal nerves.

1. deep cardiac plexus (deep to the arch of the aorta).
2. anterior and posterior pulmonary plexuses (in front and behind the root of the lung).
3. anterior and posterior oesophageal plexuses (in front and behind the oesophagus below the level of the root of the lung).
4. superficial cardiac plexus (just below the arch of the aorta, on the surface of the ligamentum arteriosum).

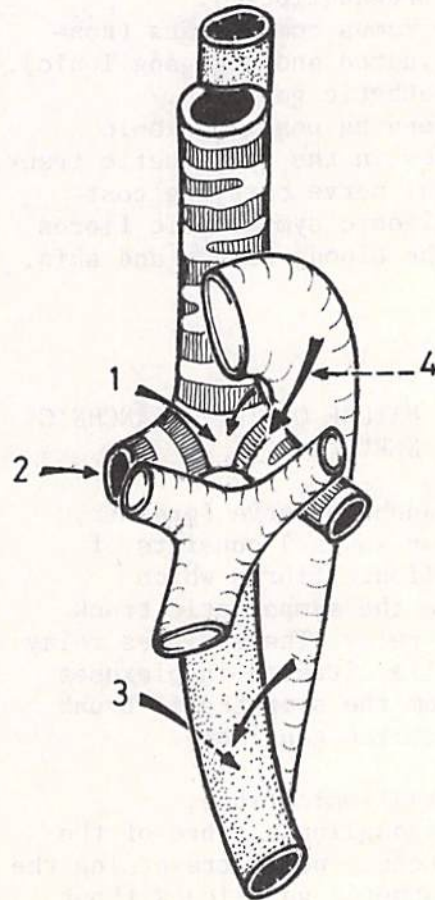


Fig.(419): FORMATION OF THE
SYMPATHETIC TRUNK

The sympathetic trunk consists of ascending and descending fibres, most of which are postganglionic fibres arising in the sympathetic ganglia. These ganglia receive preganglionic fibres from sympathetic nerve cells situated in the lateral horns of the spinal cord in the region from the 1st thoracic to the 2nd or 3rd lumbar segments.

1. sympathetic nerve cell in the lateral horn of the spinal cord.
2. preganglionic fibre passing through the ventral root of a spinal nerve.
3. ascending postganglionic fibres in the sympathetic trunk.
4. white ramus communicans (myelinated and preganglionic).
5. grey ramus communicans (non-myelinated and postganglionic).
6. sympathetic ganglion.
7. descending postganglionic fibres in the sympathetic trunk.
8. spinal nerve carrying postganglionic sympathetic fibres to the blood vessels and skin.

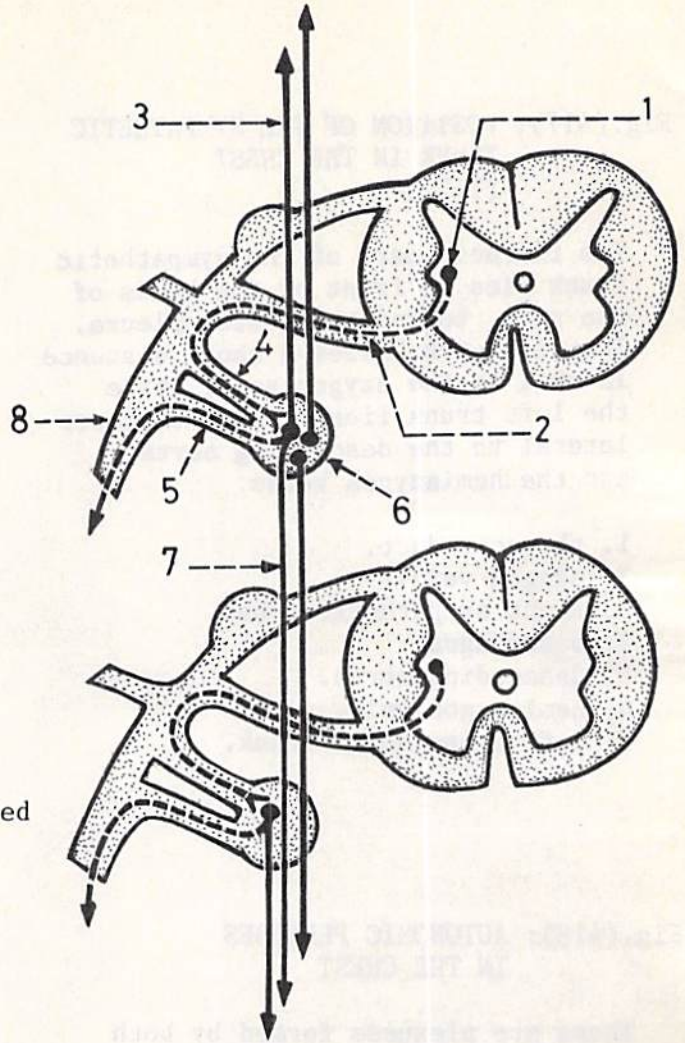
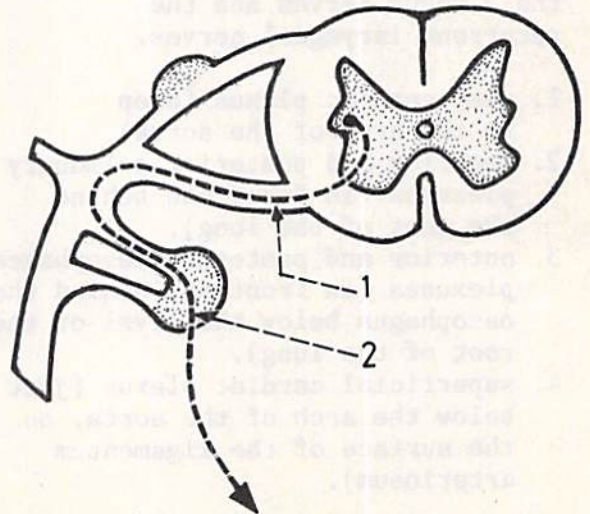


Fig.(420): NATURE OF THE SPLANCHNIC
NERVE

The splanchnic nerve (greater, lesser or lowest) consists of preganglionic fibres which traverse the sympathetic trunk without relay. These fibres relay in ganglia situated in plexuses away from the sympathetic trunk (e.g. coeliac ganglion).

1. preganglionic fibre.
2. a preganglionic fibre of the splanchnic nerve traversing the sympathetic ganglion without relay.



OESOPHAGUS

Fig.(421)

Fig.(421): POSITION AND PARTS OF THE OESOPHAGUS

The oesophagus is a vertical muscular tube which lies in front of the vertebral column. It begins in the neck opposite the 6th C.V. as a continuation of the pharynx and ends in the abdomen by joining the stomach; thus it has a cervical part, a thoracic part and a short abdominal part.

1. beginning of the oesophagus (opposite the 6th C.V.).
2. cervical part of the oesophagus (behind the trachea).
3. trachea in the superior mediastinum.
4. left bronchus.
5. descending aorta.
6. thoracic part of the oesophagus.
7. oesophageal opening of the diaphragm (opposite the 10th T.V.).
8. abdominal part of the oesophagus (the shortest and most horizontal).

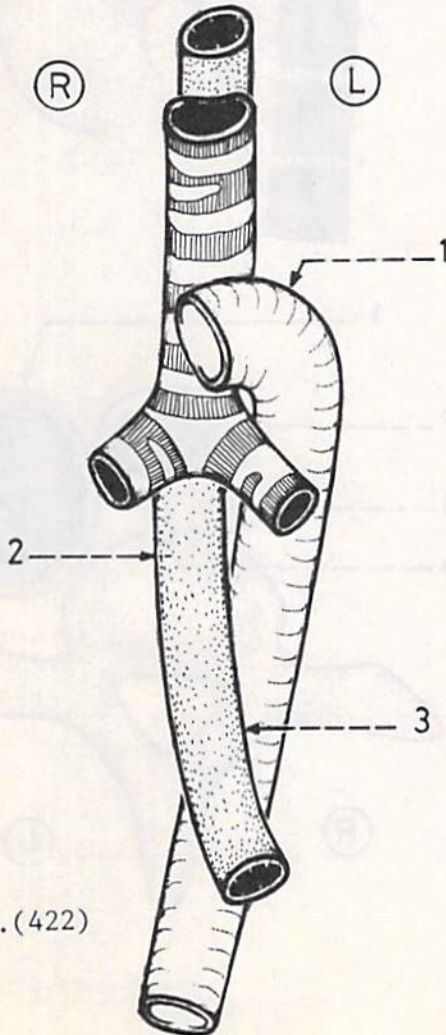


Fig.(422)

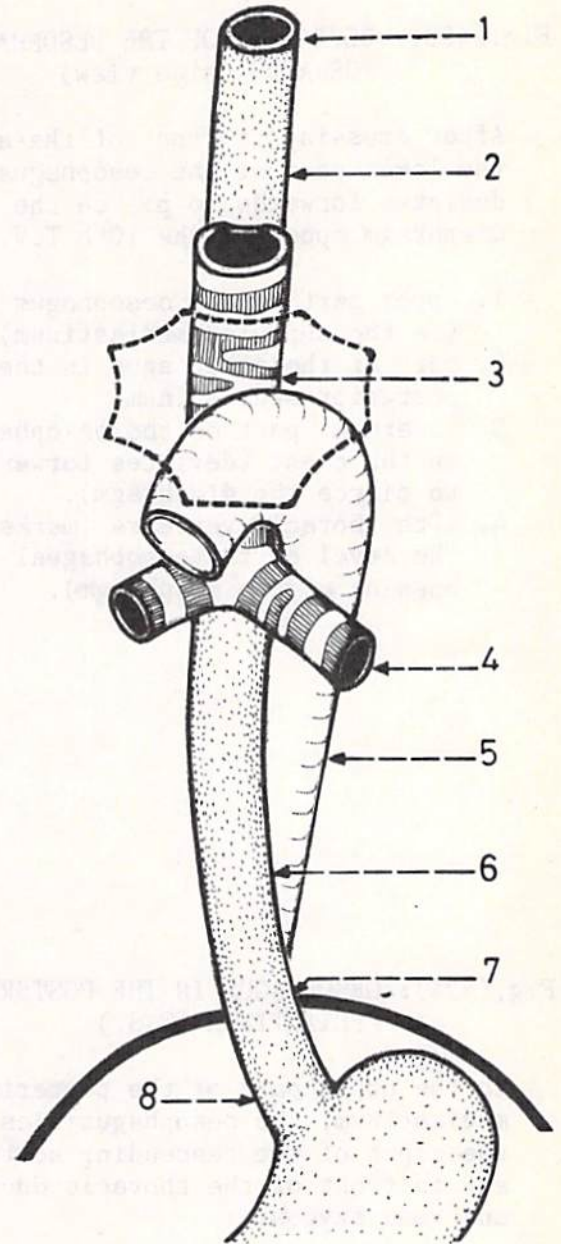


Fig.(422): DEVIATION OF THE OESOPHAGUS TO THE LEFT

At the level of the 7th T.V., the oesophagus deviates to the left where it comes in front of the descending aorta; here it has an impression on the mediastinal surface of the left lung.

1. arch of the aorta.
2. oesophagus to the right of the aorta.
3. oesophagus deviating to the left in front of the descending aorta.

Fig.(423): DEVIATION OF THE OESOPHAGUS
FORWARDS (side view)

After crossing in front of the aorta, the lower part of the oesophagus deviates forwards to pierce the diaphragm opposite the 10th T.V.

1. upper part of the oesophagus (in the superior mediastinum).
2. part of the oesophagus in the posterior mediastinum.
3. lowermost part of the oesophagus in the chest (deviates forwards to pierce the diaphragm).
4. 10th thoracic vertebra (marks the level of the oesophageal opening of the diaphragm).

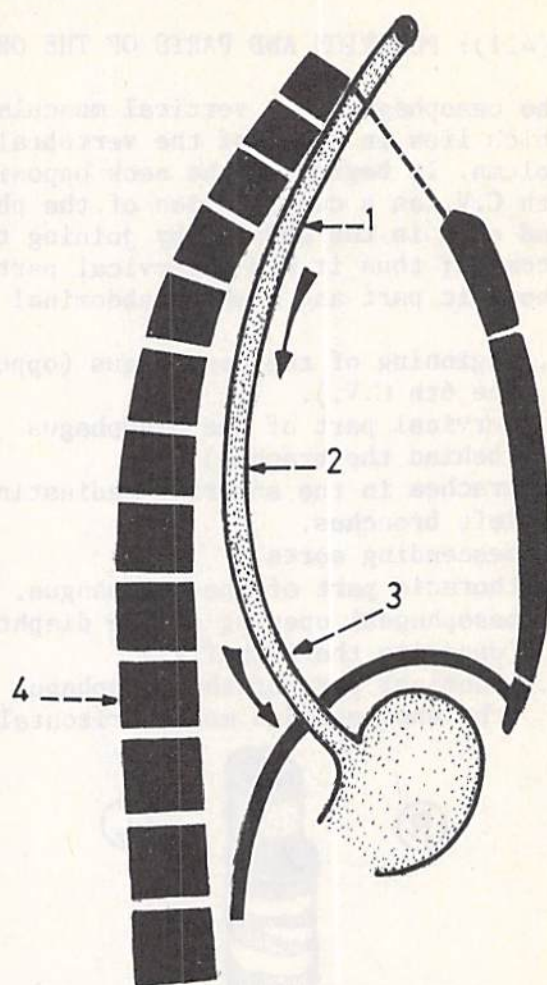
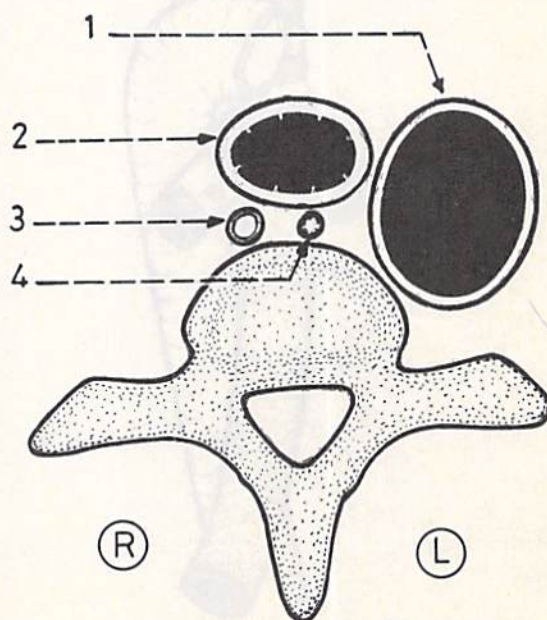


Fig.(424): OESOPHAGUS IN THE POSTERIOR
MEDIASTINUM (T.S.)

In the upper part of the posterior mediastinum, the oesophagus lies to the right of the descending aorta and in front of the thoracic duct and vena azygos.

1. descending aorta (to the left of the oesophagus).
2. oesophagus in the upper part of the posterior mediastinum.
3. vena azygos.
4. thoracic duct.



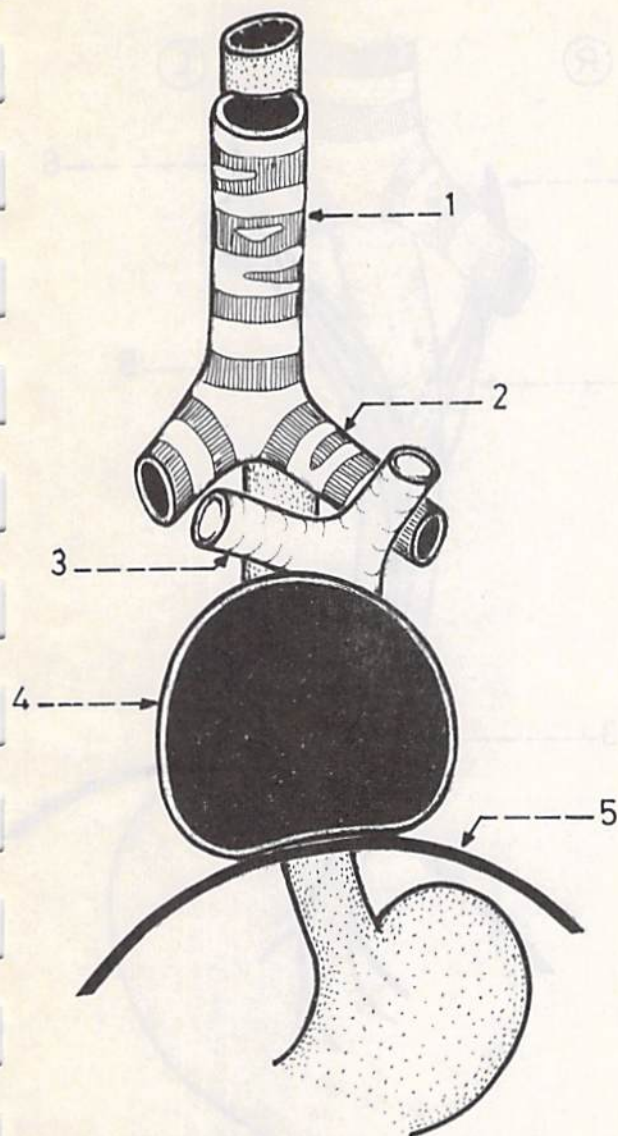


Fig.(425): ANTERIOR RELATIONS OF THE OESOPHAGUS

These are the trachea, left bronchus, right pulmonary artery, pericardium covering the left atrium and diaphragm (from above downwards).

1. trachea.
2. left principal bronchus.
3. right pulmonary artery.
4. pericardium covering the left atrium.
5. diaphragm.

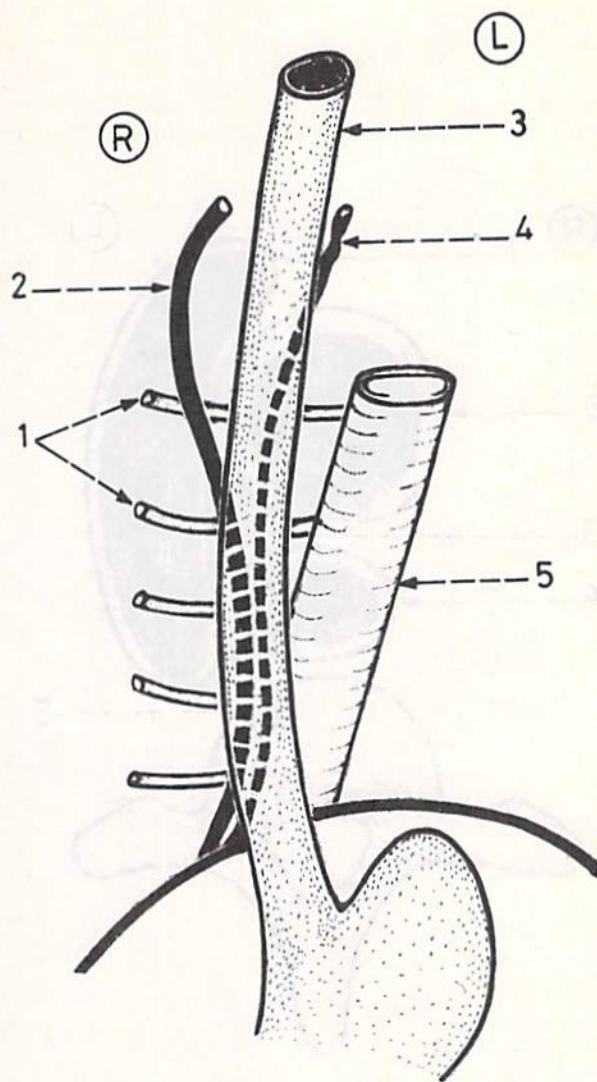


Fig.(426): POSTERIOR RELATIONS OF THE OESOPHAGUS

These are the right posterior intercostal arteries, thoracic duct, azygos vein, descending aorta and terminal parts of the hemiazygos veins.

1. right posterior intercostal arteries.
2. azygos vein.
3. oesophagus.
4. thoracic duct (deviates to the left in its upper part).
5. descending aorta.

* The terminal parts of the hemiazygos veins are not shown in the figure.

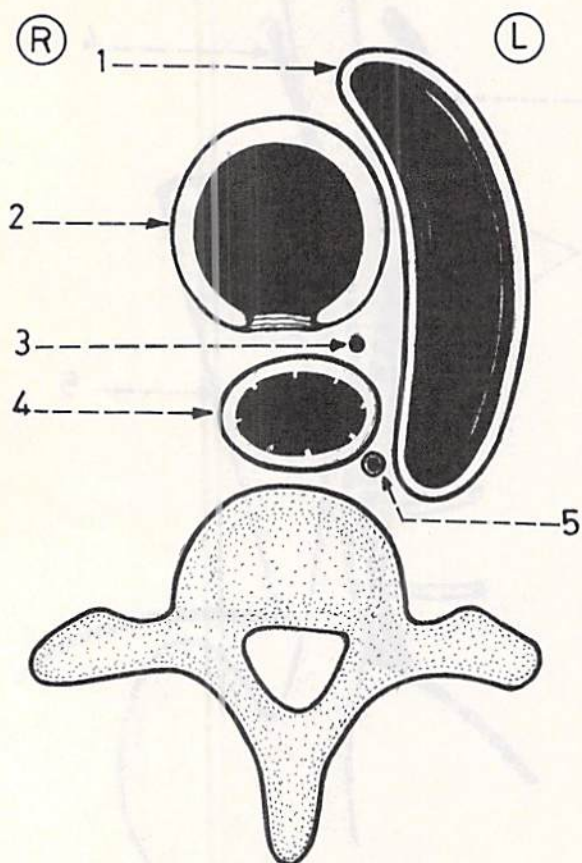


Fig.(427): OESOPHAGUS IN THE SUPERIOR MEDIASTINUM (T.S.)

In the superior mediastinum, the oesophagus lies behind the trachea with the left recurrent laryngeal nerve in the groove between them. It is related on its left side to the arch of the aorta and the thoracic duct.

1. arch of the aorta.
2. trachea.
3. left recurrent laryngeal nerve.
4. oesophagus in the superior mediastinum.
5. thoracic duct.

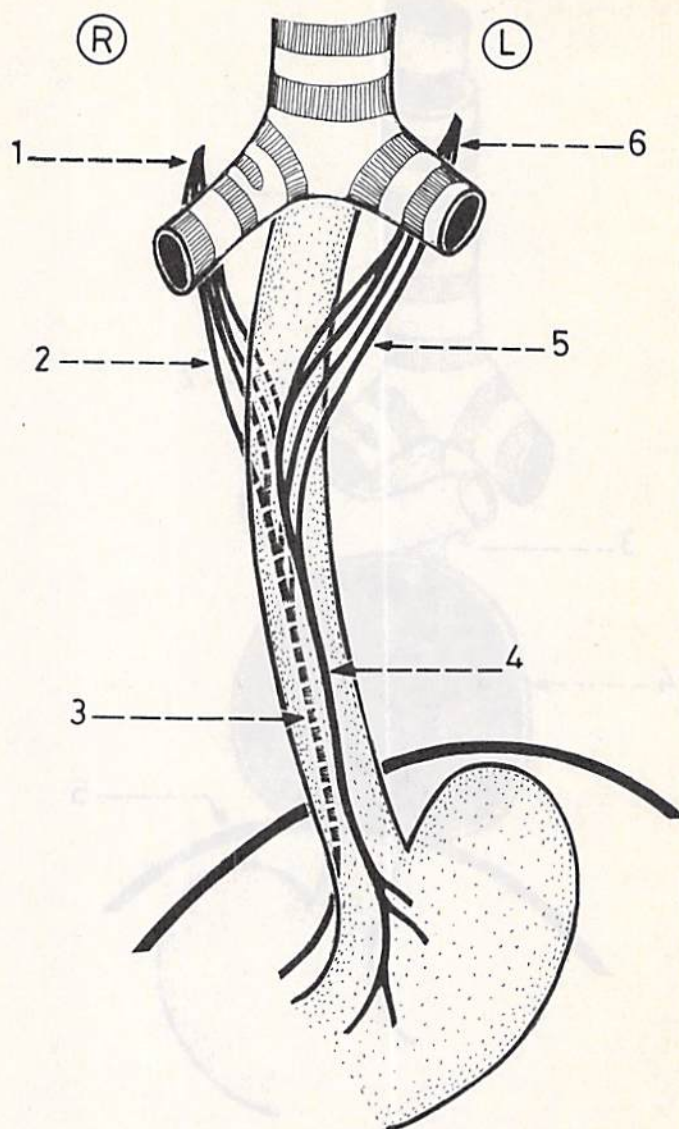


Fig.(428): RELATIONS OF THE OESOPHAGUS TO THE VAGUS NERVES OF BOTH SIDES

The right vagus nerve forms the posterior oesophageal plexus and continues as the posterior vagal trunk, while the left vagus nerve forms the anterior oesophageal plexus and continues as the anterior vagal trunk.

1. right vagus nerve.
2. posterior oesophageal plexus.
3. posterior vagal trunk.
4. anterior vagal trunk.
5. anterior oesophageal plexus.
6. left vagus nerve.

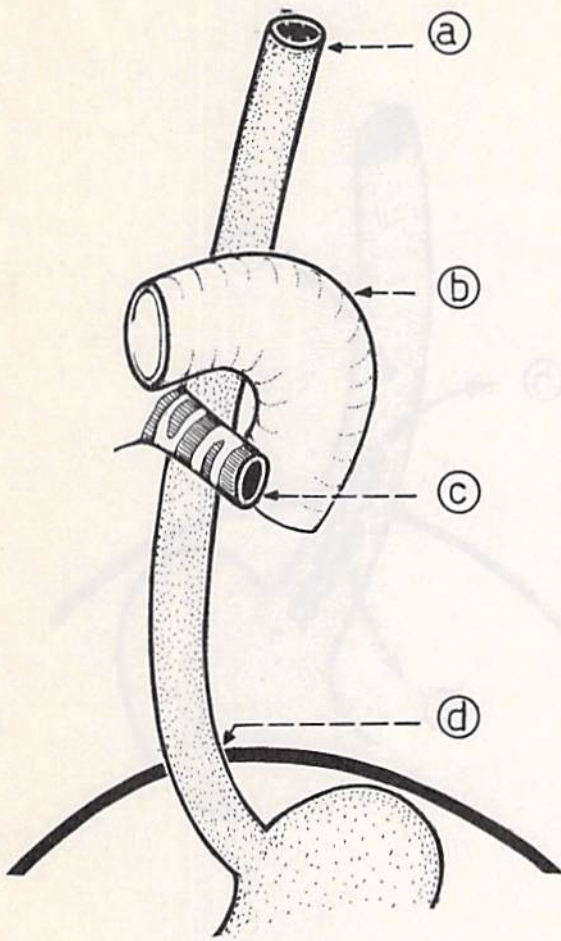


Fig.(429): CONSTRICTIONS OF THE OESOPHAGUS

The oesophagus has 4 normal constrictions:

- (a) at its beginning (6 inches from the incisor teeth).
- (b) where it is crossed by the aortic arch (9 inches from the incisor teeth).
- (c) where it is crossed by the left principal bronchus (12 inches from the incisor teeth).
- (d) where it pierces the diaphragm (15 inches from the incisor teeth).

* The sites of these constrictions are of clinical importance.

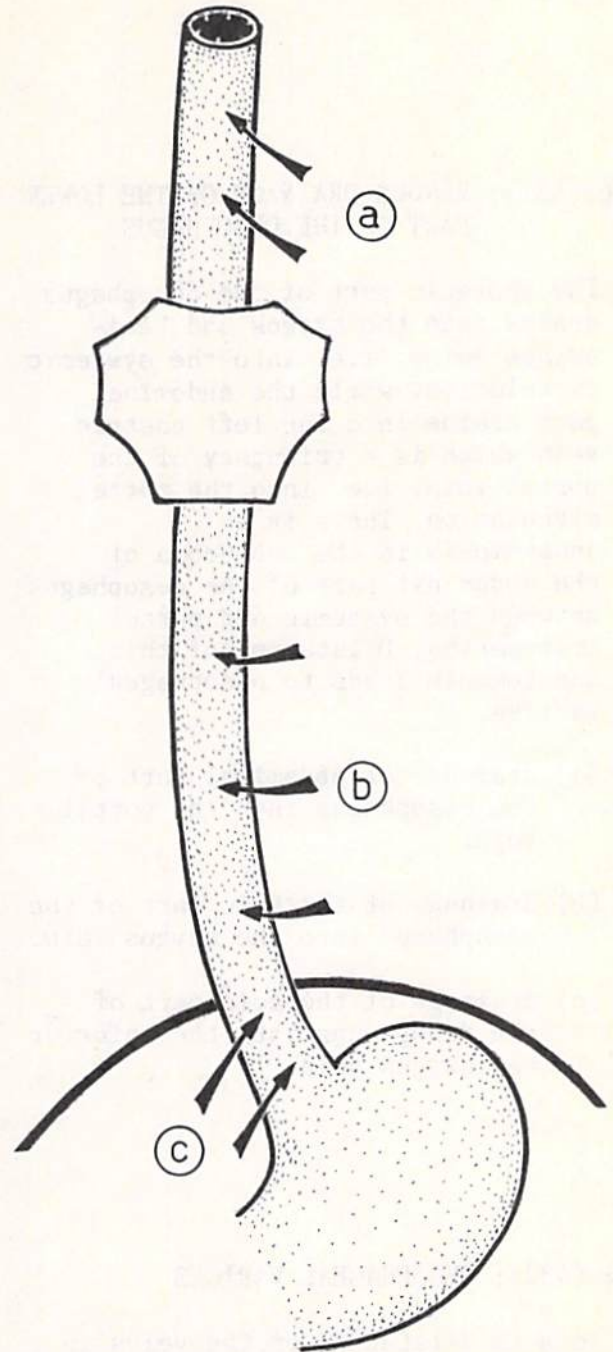


Fig.(430): ARTERIAL SUPPLY OF OESOPHAGUS

The oesophagus gets its arterial supply from 3 sources:

- (a) inferior thyroid artery (supplies the cervical part of oesophagus).
- (b) descending aorta (supplies the thoracic part).
- (c) left gastric artery (supplies the abdominal part).

Fig.(431): VENOUS DRAINAGE OF THE LOWER PART OF THE OESOPHAGUS

The thoracic part of the oesophagus drains into the azygos and hemi-azygos veins, i.e. into the systemic circulation, while the abdominal part drains into the left gastric vein which is a tributary of the portal vein, i.e. into the portal circulation. There is an anastomosis in the submucosa of the abdominal part of the oesophagus between the systemic and portal tributaries. Dilatation of this anastomosis leads to oesophageal varices.

- (a) drainage of abdominal part of the oesophagus into the portal vein.
- (b) drainage of thoracic part of the oesophagus into the azygos vein.
- (c) drainage of thoracic part of the oesophagus into the inferior hemiazygos vein.

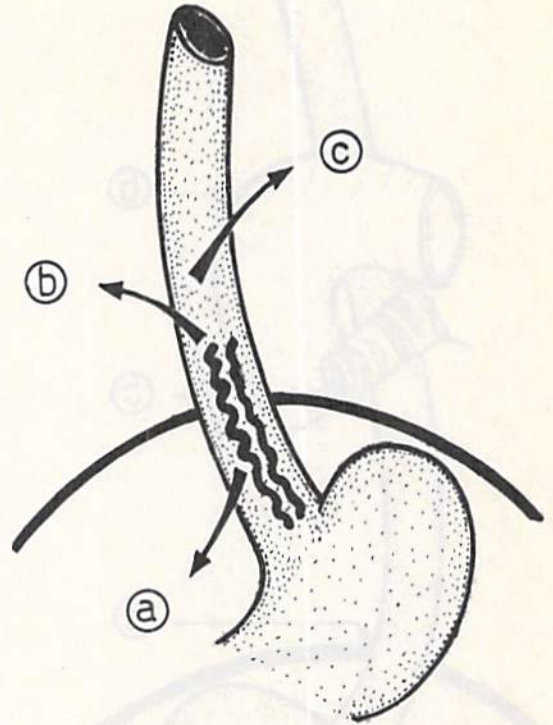
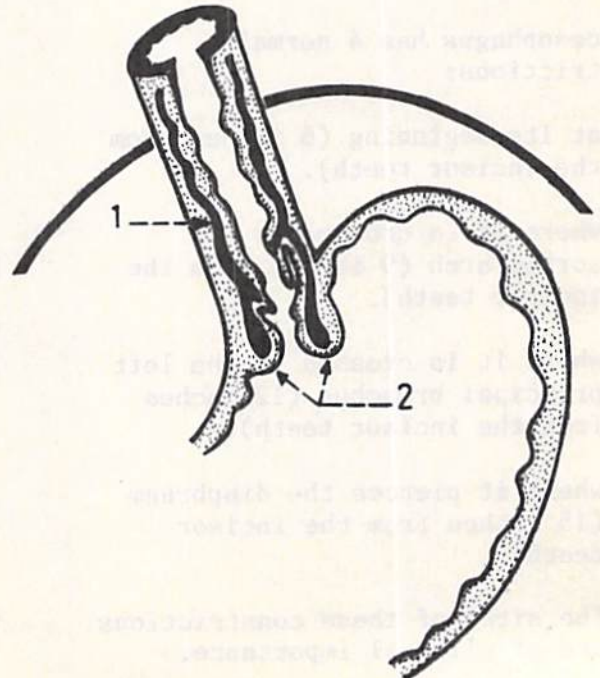


Fig.(432): OESOPHAGEAL VARICES

This is dilatation of the veins in the submucosa of the abdominal part of the oesophagus due to portal obstruction.

- 1. veins in the submucosa of the oesophagus.
- 2. oesophageal varices.



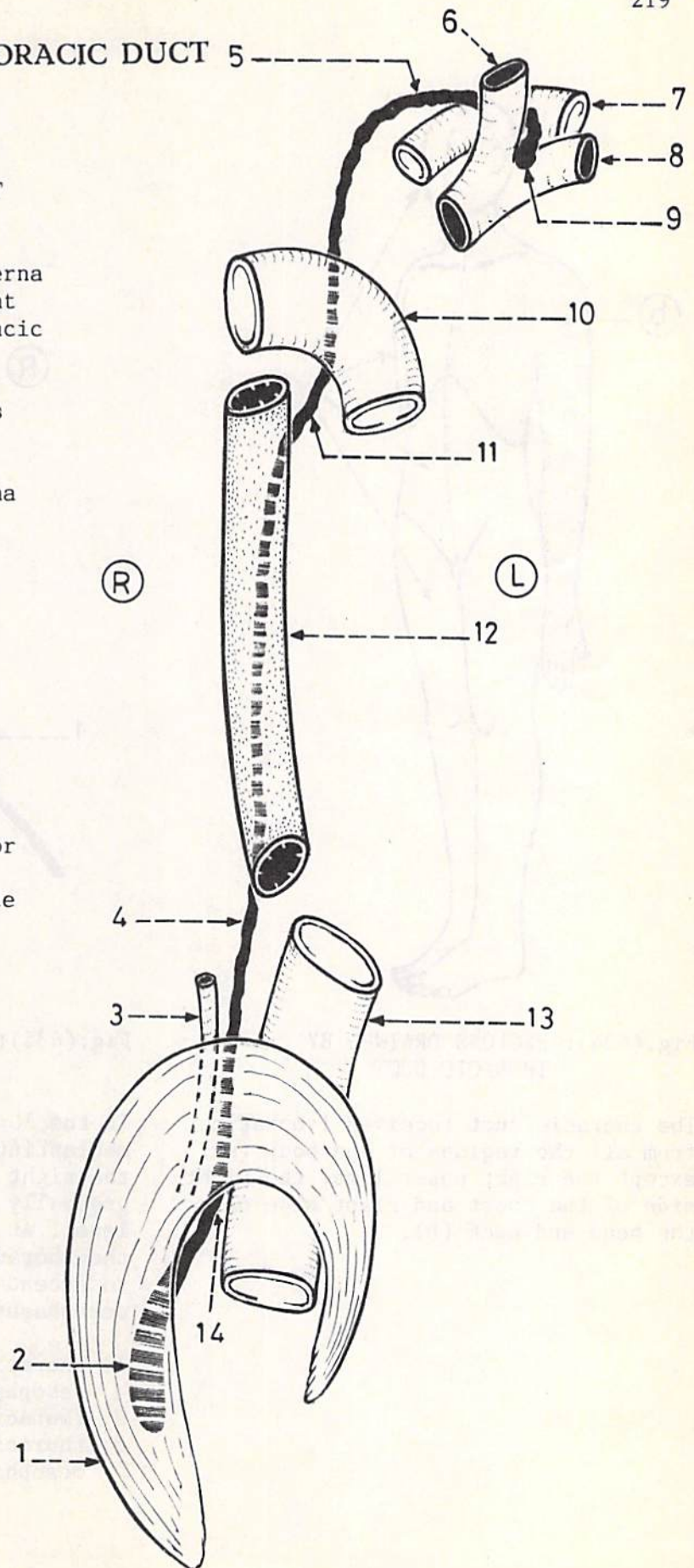
THORACIC DUCT 5

Fig.(433): COURSE OF THORACIC DUCT

It begins in the abdomen as the upward continuation of the cisterna chyli which lies behind the right crus of the diaphragm. The thoracic duct enters the chest cavity through the aortic opening of the diaphragm between the azygos vein and descending aorta. In the chest, it ascends in the posterior and superior mediastina and enters the root of the neck on the left side where it ends by joining the junction between the left subclavian vein and left internal jugular vein.

1. right crus of diaphragm.
2. cisterna chyli (behind the right crus).
3. azygos vein (to the right of thoracic duct).
4. thoracic duct in the posterior mediastinum.
5. thoracic duct in the left side of the root of the neck.
6. left internal jugular vein.
7. left subclavian artery.
8. left subclavian vein.
9. end of the thoracic duct.
10. arch of the aorta.
11. thoracic duct deviating to the left to enter the superior mediastinum opposite the 5th T.V.
12. oesophagus in the posterior mediastinum.
13. descending aorta (to the left of the thoracic duct).
14. thoracic duct in the aortic opening of diaphragm.

* The thoracic duct is the main lymphatic duct in the body.



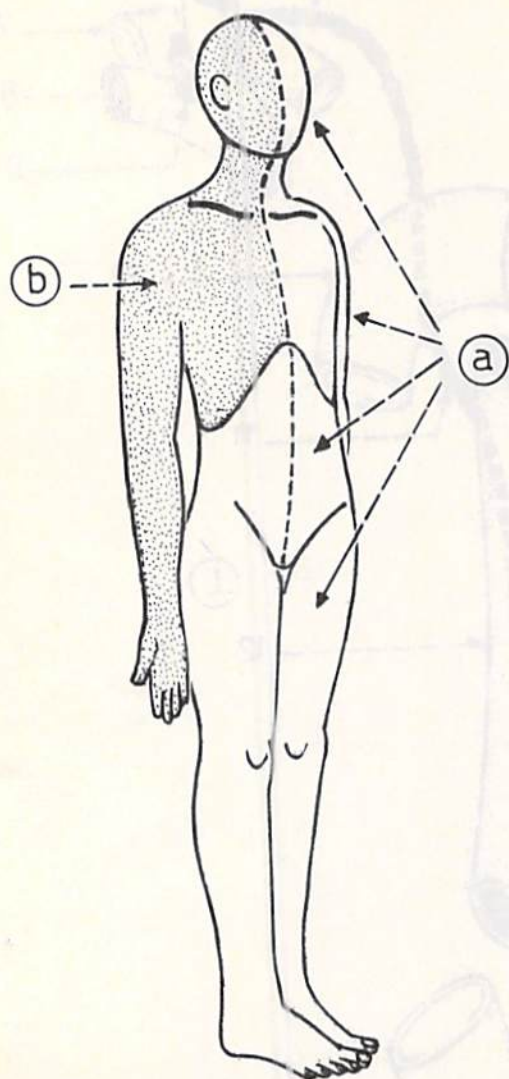


Fig.(434): REGIONS DRAINED BY THORACIC DUCT

The thoracic duct receives lymphatics from all the regions of the body (a), except the right upper limb, the right side of the chest and right side of the head and neck (b).

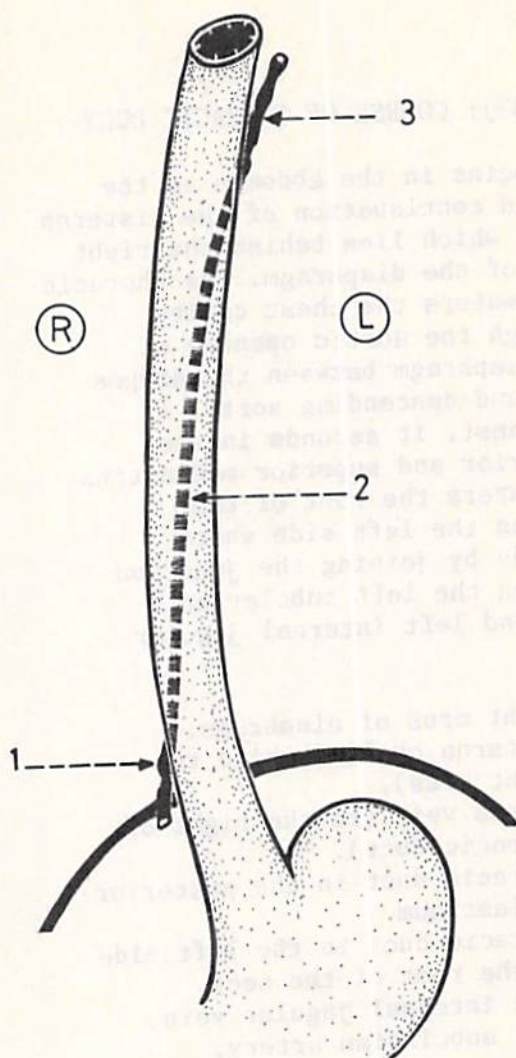


Fig.(435): RELATION OF THORACIC DUCT TO THE OESOPHAGUS

In the lower part of the posterior mediastinum, the thoracic duct lies to the right of the oesophagus, but it gradually comes behind it at a higher level. At the level of the 5th T.V., the thoracic duct deviates to the left to ascend on the left side of the oesophagus in the superior mediastinum.

1. thoracic duct to the right of the oesophagus lower down.
2. thoracic duct behind the oesophagus.
3. thoracic duct on the left side of the oesophagus (in the superior mediastinum).

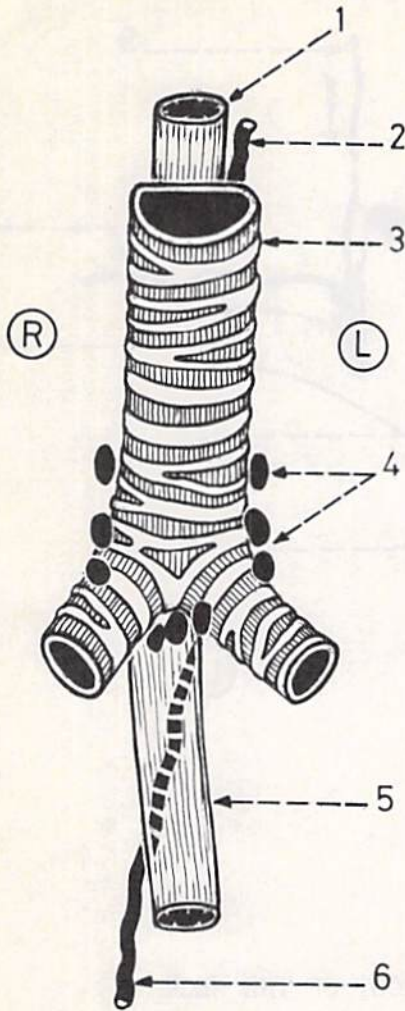


Fig.(436): DEVIATION OF THORACIC DUCT TO THE LEFT

The thoracic duct deviates to the left behind the oesophagus, opposite the 5th T.V., to enter the superior mediastinum where it ascends on the left side of the oesophagus.

1. oesophagus.
2. thoracic duct in the superior mediastinum.
3. trachea.
4. tracheobronchial lymph nodes.
5. oesophagus in the posterior mediastinum.
6. thoracic duct in the posterior mediastinum.

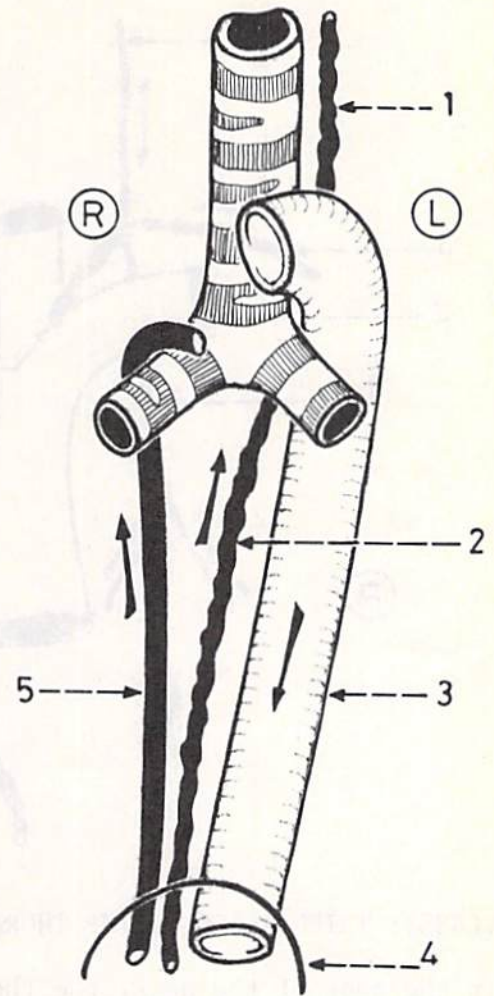


Fig.(437): SIDE RELATIONS OF THORACIC DUCT IN THE POSTERIOR MEDIASTINUM

The duct is related on the right side to the azygos vein and on the left side to the descending aorta.

1. thoracic duct in the superior mediastinum.
2. thoracic duct in the posterior mediastinum.
3. descending aorta.
4. aortic opening of diaphragm.
5. azygos vein.

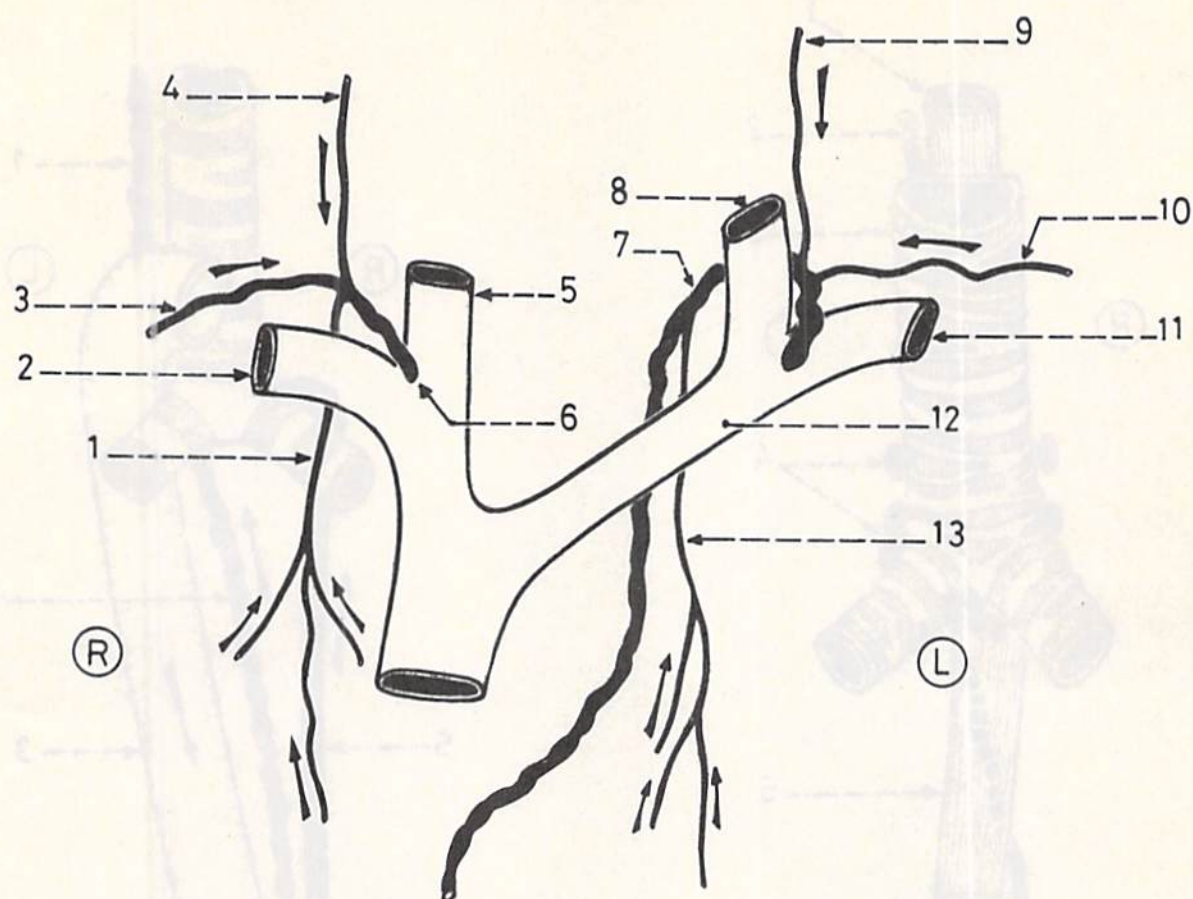


Fig.(438): TRIBUTARIES OF THE THORACIC DUCT IN THE ROOT OF THE NECK

In the root of the neck, the thoracic duct receives 3 lymph trunks: left jugular trunk (from the left 1/2 of head and neck), left subclavian trunk (from left upper limb) and left bronchomediastinal trunk (from left 1/2 of the chest). On the right side, the right lymphatic duct corresponds to the thoracic duct and receives similar tributaries from the right side.

1. right bronchomediastinal lymph trunk (from right 1/2 of chest cavity).
2. right subclavian vein.
3. right subclavian lymph trunk (from right upper limb).
4. right jugular lymph trunk (from right 1/2 of head and neck).
5. right internal jugular vein.
6. end of right lymphatic duct.
7. thoracic duct in the root of the neck.
8. left internal jugular vein.
9. left jugular lymph trunk (from left 1/2 of head and neck).
10. left subclavian lymph trunk (from left upper limb).
11. left subclavian vein.
12. left brachiocephalic vein.
13. left bronchomediastinal lymph trunk (from left 1/2 of chest cavity).

LYMPH NODES OF THE CHEST

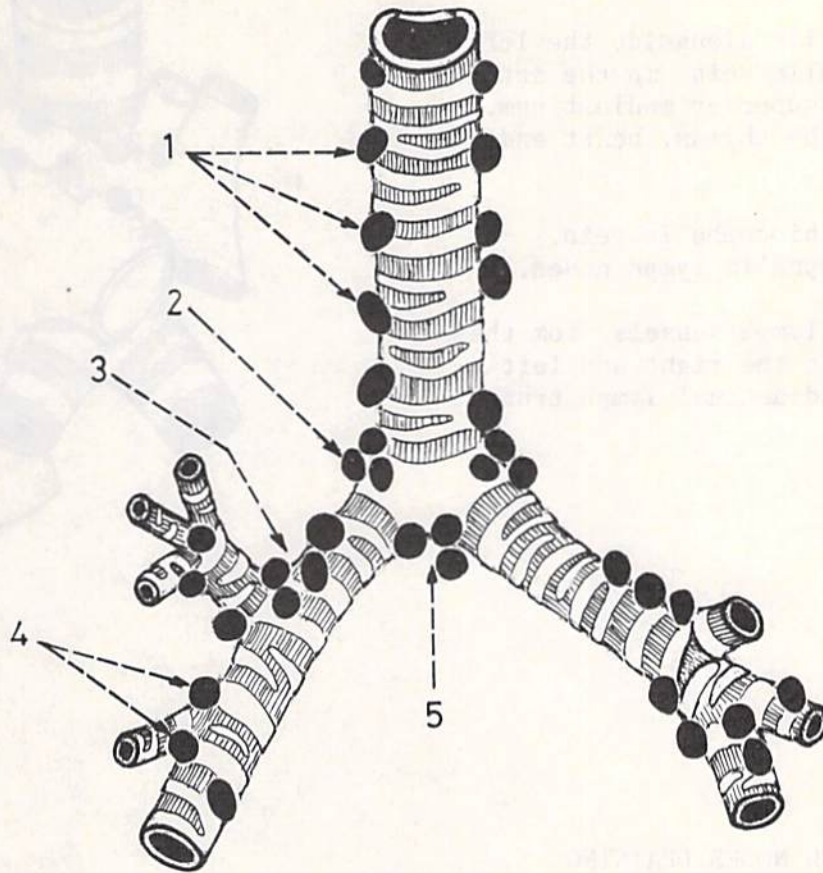


Fig.(439): LYMPH NODES RELATED TO THE TRACHEA AND BRONCHI

These lymph nodes are arranged into 5 main groups: paratracheal (on each side of the trachea), superior tracheobronchial (just above the bifurcation of the trachea), inferior tracheobronchial (just below the bifurcation of the trachea), bronchopulmonary (at the hilum of the lung) and pulmonary (within the lung substance along the divisions of the bronchi). Lymph vessels from all these nodes join the bronchomediastinal lymph trunk (one on each side).

1. paratracheal nodes (along the side of the trachea).
2. superior tracheobronchial nodes (just above the bifurcation of trachea).
3. bronchopulmonary nodes (in the hilum of the lung).
4. pulmonary nodes (in the lung tissue).
5. inferior tracheobronchial nodes (just below the bifurcation of trachea).

Fig.(440): BRACHIOCEPHALIC LYMPH NODES
(anterior mediastinal nodes)

These nodes lie alongside the left brachiocephalic vein, in the anterior part of the superior mediastinum. They drain the thymus, heart and pericardium.

1. left brachiocephalic vein.
2. brachiocephalic lymph nodes.

* Efferent lymph vessels from these nodes join the right and left bronchomediastinal lymph trunks.

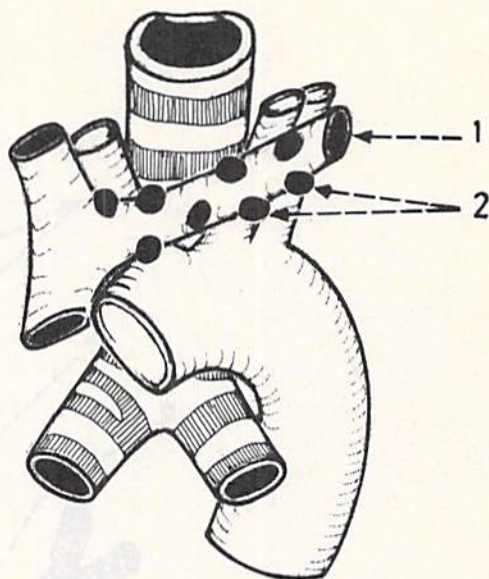


Fig.(441): LYMPH NODES DRAINING
THORACIC VISCERA

These nodes are situated at 3 main sites: behind the manubrium sterni (brachiocephalic or anterior mediastinal), around the bifurcation of the trachea and at the hila of both lungs (tracheobronchial and bronchopulmonary) and behind the pericardium in the posterior mediastinum (posterior mediastinal).

1. brachiocephalic (anterior mediastinal) nodes: drain the thymus, heart and front of pericardium.
2. tracheobronchial and bronchopulmonary nodes: drain the trachea and lungs.
3. posterior mediastinal nodes: drain the oesophagus and back of pericardium as well as the diaphragm.

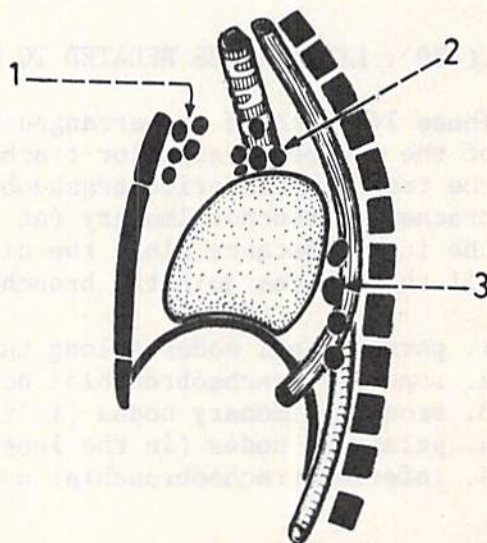


Fig.(442): LYMPH NODES RELATED TO THE INTERCOSTAL SPACES

These nodes lie at the anterior ends of the intercostal spaces along the internal thoracic vessels (parasternal nodes) and at the posterior ends of the intercostal spaces close to the heads and necks of the ribs (intercostal nodes).

1. intercostal nodes (at the posterior ends of the intercostal spaces).
2. parasternal nodes (at the anterior ends of the intercostal spaces along the internal thoracic artery).

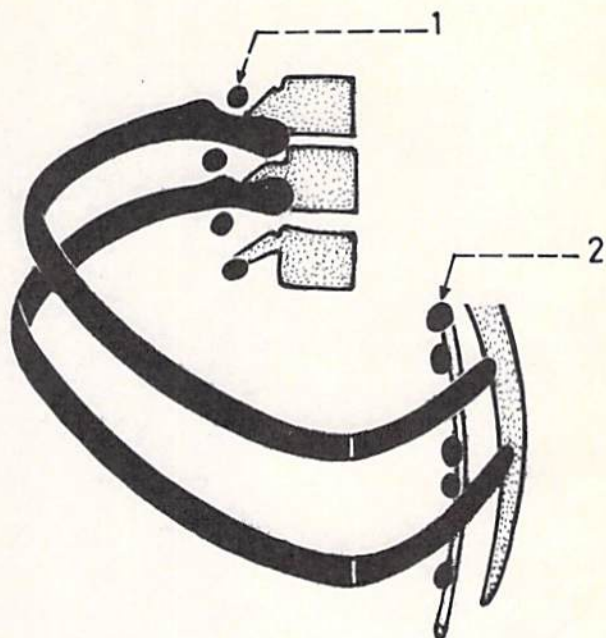


Fig.(443): LYMPH NODES DRAINING THORACIC WALLS

These nodes are situated at 3 main sites: behind the anterior ends of the intercostal spaces (parasternal nodes), at the posterior ends of the intercostal spaces (intercostal nodes) and on the upper surface of the diaphragm (diaphragmatic or phrenic nodes).

1. intercostal nodes (close to the posterior chest wall).
2. phrenic nerve.
3. parasternal nodes (close to the anterior chest wall).
4. anterior diaphragmatic nodes.
5. lateral diaphragmatic nodes.
6. posterior diaphragmatic nodes.

